Annexure-I

Project title: **Habitat Improvement and Conservation Breeding of the Great Indian Bustard: An Integrated Approach**

Implementation agencies:

(1) Wildlife Institute of India
(2) Forest Departments – Rajasthan, Gujarat, Maharashtra

Collaborating agencies:

(1) Bombay Natural History Society
(2) The Corbett Foundation
(3) World Wide Fund for Nature

Budget: Rs. 33.85 crores

Timeline: September 2015 – December 2020

भारतीय वन्यजीव संस्थान
Wildlife Institute of India

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1. Project background

Great Indian Bustard *Ardeotis nigriceps* (henceforth GIB) is one of the rarest birds in the world. With ~200 individuals left, almost exclusively in India, the species is listed as Critically Endangered (IUCN 2011) and Schedule I (the highest protection status, Wildlife (Protection) Act, 1972). Their populations have steadily declined by 75% in last 30 years and are facing imminent extinction risk unless serious management interventions are applied (Dutta et al. 2011). Historically, GIB was distributed throughout the western half of India, but, currently they are found in five fragmented pockets. According to our recent population assessment (Dutta et al. 2015), the largest population of 169±70 birds occurs in Thar landscape of Rajasthan (Desert National Park in Jaisalmer alongside Jodhpur). The other populations are <15 birds each, occurring in Gujarat (Lala-Naliya Sanctuary and its neighbourhood in Kachchh), Maharashtra (Bustard Sanctuary in Solapur, alongside Chandrapur and Nagpur), Andhra Pradesh (Rollapadu Sanctuary and its neighbourhood in Kurnool) and Karnataka (Bellary) (Dutta et al. 2011).

Research shows that GIB is an omnivorous bird primarily feeding on insects, fruits, and harvested crops. They live in dry, open landscapes comprising short grasslands, open scrub, and rain-fed agriculture. They are traditional to their breeding grounds, where, males display in open, well-grazed grasslands to attract females who prefer moderately tall and less-grazed grassland for nesting. Thus, a mosaic of short and tall vegetation with little disturbance is ideal for breeding. Their non-breeding usage is vast and distributed across well-connected, productive areas with short fruiting shrubs and fallow fields. However, their seasonal movement patterns and critical resource requirements for nesting, chick-rearing and lekking are complex and poorly understood. Existing research on GIB and related species shows that large heterogeneous agro-grassland patches have highest conservation value (del Hoyo et al. 1996). Although these birds are intolerant to intensive development, they are compatible with traditional, low-intensity land uses that can create some win-win conservation situations (Dutta and Jhala 2014).

The species has declined due to compounding effects of direct and indirect human exploitations on their slow life-history traits. They were subjected to exhaustive hunting and egg collection in the past that reduced their population to ~1260 birds in 1969 (Dharmakumarsinhji 1971). They are still hunted in Pakistan where birds from India perhaps migrate seasonally, and also in Thar, Rajasthan. However, their contemporary decline is largely due to prevailing habitat loss as dry grasslands have been marginalized as 'unproductive wastelands' and progressively converted to other land uses since colonial times. Recent developments in irrigation and farming technologies have intensified agriculture in bustard habitats and changed cropping practices from seasonal to year-round, intensive crops. This has led to food scarcity, pesticide contamination, and habitat loss. Development activities like mining, industries, power projects, wind turbines, and associated infrastructure growth (buildings, electricity and road networks) have caused severe habitat degradation and disturbance to birds. Being low and heavy flyers, they face a high risk of fatal collisions with power-lines that are difficult to detect from afar. Feral dog populations have increased in their habitats, and along with native predators (fox, mongooses, and cats), they have increased predation pressure on nests and chicks and reduced recruitment. Past efforts of banning human activities to create bustard Sanctuaries over large human-use landscapes, without appropriate settlement

of land rights, have generated bitterness among local people, lack of conservation support, and backlash. These factors have in turn to local extinctions from some Sanctuaries. Local people and managers are not sufficiently aware of the conservation benefits of grasslands and the scientific ways to manage them. While, the traditional ways to manage these habitats are eroding due to rapid socio-ecological changes driven by state policies (Dutta et al. 2013). Although most remaining breeding habitats are protected to some level, the vast movements of bustards expose them to the threats mentioned above in the non-breeding habitats, defeating the purpose of protecting small breeding reserves. Since these large bustard landscapes cannot be freed from human uses, a mixed approach of Protected Area based conservation of breeding habitats and coexistence with compatible human land uses in adjoining landscapes best suits the situation. Effective conservation of these landscapes would require information on species' ranging patterns, relative magnitudes and distribution of threats, and ways to reconcile the species' ecological needs and livelihood concerns that are poorly known. Furthermore, management authorities in many areas exhibit poor enforcement ability due to inadequate staff and infrastructure, lack of motivation, and inaccessibility.

Concerned about the extinction crisis of GIB, Indian conservation circles have proposed the Government to adopt strategic recovery plans for the species as a flagship of dry grasslands. In light of these issues, the National Guidelines for Bustard Recovery Plans (Dutta et al. 2013) strongly recommend filling research gaps, improving habitat, improving enforcement capacity, and engaging communities in conservation. However, the implementation of in-situ conservation measures require some gestation time, but, the population size of GIB (with no birds in captivity) is too small to sustain such delays. Thus, a captive population needs to be secured for supplementing wild populations and reintroducing birds into restored habitats in favorable times.

We propose an overarching project that integrates all these components into a holistic conservation plan for the priority bustard landscapes of Rajasthan, Gujarat, and Maharashtra. The proposed activities will be undertaken in collaboration with State Governments, local NGOs, and research organizations so as to pool knowledge/expertise and ensure timely and effective implementation. Since both the endangered bustards of dry grasslands – great Indian bustard and lesser florican – share habitats, these activities will supplement and complement each other's needs. In doing so, habitats that support a plethora of other endangered wildlife, such as the spiny-tailed lizard *Saara hardwickii*, chinkara *Gazella bennettii* and foxes *Vulpes* spp, will be restored.

2. Goals and objectives

The broad goals and objectives of this project are as follows:

- **Conservation Breeding**

Developing and running Conservation Breeding Center to secure captive populations of great Indian bustard and (if needed) lesser florican as insurance against extinction and (if possible) subsequent reintroduction into restored habitats

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- **Applied research**

Undertaking targeted research for:

a) prioritizing conservation areas, b) characterizing threats, c) monitoring populations and habitats to assess the effectiveness of management actions, d) assessing local communities' livelihood concerns and willingness to adopt bustard-friendly land uses, and e) comprehensive understanding of population genetics to inform conservation management

- **Capacity-building and awareness**

a) Improving protection enforcement through training of Forest staff and implementation of technology aided patrolling , b) sensitizing decision-makers, managers and local communities on bustard conservation, c) raising public awareness and support for bustard conservation through awareness materials, and d) incentivizing local land users to adopt bustard-friendly land uses

- **Pilot implementations for surgical habitat management**

Demonstrating best practices for habitat improvement through pilot/experimental surgical interventions that will be subsequently replicated by State Forest Departments

3. Scope of work

Conservation breeding

The Ministry of Environment, Forests and Climate Change (henceforth MoEFCC) has decided to commence a national Conservation Breeding Programme for GIB to secure an insurance population. These captive birds can be reintroduced into restored habitats if conditions are favorable in future. This program will involve State Governments of Rajasthan, Gujarat and Maharashtra as the main partners, and will be supervised by the Wildlife Institute of India. The National CAMPA funds will be utilized in setting up the infrastructure for this Captive Breeding Facility in the first four years, running it for 25-30 years, and subsequently releasing and monitoring the birds between 30-35 years. The roadmap for this activity has been broadly outlined through consultative workshops, but a detailed program plan has to be developed through collaboration with expert agencies or personnel in the first two years of the project. Given the critically endangered status of the species, this program should not be treated as a trial but a fully fledged activity with cutting-edge infrastructure and expertise. For smooth functioning, sustained financial support, respective roles/responsibilities, and cooperation between the stakeholders, a project document or memorandum of understanding needs to be formulated in consensus with partner agencies.

Applied research

Existing/potential bustard habitats have to be identified for conservation management and objectively monitored to assess management effectiveness. This entails developing and implementing systematic and scientific surveys across the ranges of great Indian bustard and lesser florican to generate baseline information on their population parameters and monitor their changes over space and time.

Bustards undertake wide movements across large landscapes that cannot be entirely conserved. Although birds are protected within small breeding reserves, they are exposed to various emerging threats during such movements in unprotected landscapes. Bustard conservation will only be successful if these threats are mitigated at the landscape-level. This requires information on ranging patterns of many birds from different landscapes so that intensively used areas, and connectivity corridors/flyways can be identified and prioritized for conservation investment and minimization of development. The advent of satellite telemetry has opened up a new horizon for remotely monitoring movement patterns of such wide-ranging species. Such information can be analyzed to prioritize development vs. restrictive-use zones.

In addition to understanding bird movements, spatial distributions of multiple threats and their relative impacts on bustard need to be characterized for effectively mitigating threats at landscape-scale. Therefore, research aimed at mapping of power-line networks, pesticide-prevalence, and dog densities are required across landscapes.

Finally, there is a need to understand the genetics of bustard populations to manage them effectively. A study based on mitochondrial DNA suggested very low genetic diversity and effective population size and indicated no phylogeographic structure of great Indian bustard females across the country (Ishtiaq et al. 2011). These inferences need to be strengthened with further evidence based on nuclear microsatellite markers. Nuclear microsatellite markers provide information on both genders, and since they have a higher mutation rate when compared to mitochondrial DNA, they can reflect recent demographic events of conservation importance. Thus, a combination of mitochondrial and nuclear marker-based approaches will provide holistic inferences on processes affecting bustard populations that cut across demographic classes and time scales. These combined inferences entail a comprehensive understanding of a) whether populations are disconnected or continue to exchange individuals; b) the rate and direction of such genetic exchange and how that is influenced by distance, demography and anthropogenic factors; c) the degree and timing of genetic bottlenecks and other demographic events experienced by the remaining populations; d) the ecological/geological processes that have shaped the past and present genetic structure/composition; and e) how to conserve the present genetic diversity in wild and captive populations. Understanding these aspects have strong implications on both in-situ and ex-situ management. The rarity and sparse distribution of GIB preclude precise population assessment through observation-based approaches (discussed in Dutta et al. 2015). Therefore, another potential and important application of genetics would be to integrate molecular identification of individuals with spatial capture-recapture models to obtain precise estimates of local (small-scale) population abundances. However, some of the above questions might be difficult to answer at this moment considering the rarity of bustards that constraints collection of adequate genetic samples and the unavailability of historical samples.

Capacity-building and awareness

a) To strengthen protection measures across large GIB landscapes, patrolling ability of Forest Department needs to be improved by recruiting an adequate number of trained forest guards. It has been

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noted that frontline staff in GIB landscapes have very low motivation and capacity to enforce law partly because of the harsh and remote field conditions of these areas. Their performance needs to be significantly enhanced by providing better incentives, appropriate training, necessary infrastructure and equipment, and establishing information and vigilance networks through regular communication with local people.

b) Bustards share their habitats with multiple stakeholders: local communities who depend on these habitats for subsistence; forest department that is empowered to protect these habitats; government officers from revenue, agriculture, animal husbandry, dairy and power departments whose agendas might be in conflict with the interest of bustard conservation; and private industrialists whose activities might be degrading these habitats. The key stakeholders in each of the bustard landscape have to be identified and sensitized through meetings and workshops to make them aware of the ecological hazards of unplanned development in grasslands.

c) Local people depending on bustard habitats for subsistence needs have to be encouraged to opt for agro-environmental schemes that incentivize bustard-friendly practices to balance conservation and livelihoods. Some bustard-friendly land uses are organic farming of seasonal food crops, reducing cropping frequency and stall-feeding livestock during monsoon. National CAMPA funds can be utilized to initiate pilot projects where households who have adopted these practices are compensated for the foregone production cost. Such measures have resulted in a dramatic revival of little bustard population in Europe (Bretagnolle et al. 2011). To enable this course of community-based conservation, workshops have to be conducted in select villages within priority conservation areas. Effects of the above activities on bustard population and threat parameters need to be monitored so that policy-makers and managers can replicate the effective ones at larger scales. These activities have immense potential in sustaining green development and reducing our carbon footprint.

d) It has also been noted that general public have poor awareness of bustard and grassland conservation. Publicity materials such as posters, boards, and short movies need to be developed in collaboration with experts to raise general awareness of these issues.

Pilot implementations of surgical habitat management

a) Bustard breeding areas are public-private mixed ownership lands not entirely controlled by Forest Department, which makes it difficult to implement protective measures. There is a need to acquire revenue lands and some private lands to consolidate contiguous breeding areas and critical non-breeding areas. For instance, some small grassland patches within agricultural matrix might allow the birds to persist and needs to be protected from land use conversion in future. To facilitate this process, strategically located lands have to be identified and acquired by Forest Department utilizing State CAMPA funds. This activity can be viewed as compensatory land acquisition for industrial activities under the Forest (Conservation) Act, 1980. In some parks, rationalization of the boundary is also required in light of new information on species' distributions and persistent resentment or growing antagonism of local people.

b) Only 4-5 GIB breeding sites are left that are of critical importance to the species' survival, but do not contribute significantly to the persistence of other species. These sites need to be secured by legal status and total ban of consumptive human activities (excluding authorized management, protection, and research) during the breeding months: June-October. Enclosures that restrict livestock and nest predators need to be erected before the next breeding season. All mammalian predators (dogs, pigs, jackals, foxes, cats, and mongooses) need to be removed from these enclosures to reduce predation of GIB nests/chicks and improve recruitment. To restrict GIB inside enclosures during the vulnerable breeding phase, thereby minimizing human disturbances and improving recruitment rates, GIB food plants can be grown in enclosures.

c) Overhead power lines have to be routed underground or marked prominently to minimize the risk of fatal bird collisions (Silva et al. 2014) in priority conservation areas. Wind turbines should also be discouraged in these areas as they increase power-line networks and disturbances. Scientific dog sterilization, removal, and subsequent monitoring program have to be undertaken in priority conservation areas. This will benefit not only GIB but also other desert fauna since feral dogs are a major threat to all wildlife through the spread of diseases and predation.

4. Approaches and methodologies

The following activities will be undertaken by the Wildlife Institute of India in collaboration with its partner NGOs and State Forest Departments in research identified areas within bustard landscapes.

Activity 1: Conservation Breeding

A conservation breeding facility would be developed by the Wildlife Institute of India in consultation/collaboration with international bustard breeding agencies. The founder captive population would be formed from wild-collected and artificially incubated eggs rather than adult birds. Eggs have very low survival probability in the wild, whereas, capturing of wild birds can jeopardize the fate of in-situ populations. Set of favorable conditions (relatively higher rainfall, lower temperature and proximity to source population) has to be ensured to maximize the growth of the captive population. Keeping this in mind, a site near Mandvi (Kachchh, Gujarat) has been selected for developing the main center. Additionally, a satellite center has to be developed near Jaisalmer (Rajasthan) which is the most potential area for egg collection. The satellite center will have a small incubator, hatchery, and a chick holding facility, with uninterrupted water and electric supply. The role of satellite center would be to hold eggs until sufficient numbers have been collected at one go (5-8 per year) that would be transported by road in temperature-regulated containers to the main center. The main center would be developed with incubation rooms, hatcheries, juvenile and adult bird holding and breeding facilities, food processing facility, staff quarters and office, with uninterrupted electricity and water supply. The main and satellite centers would be constructed by the Civil Construction Unit of MoEFCC, with which WII has a Memorandum of Understanding. Centers would be constructed after appropriate planning with bustard breeding experts and zoo architects. The center will be run by professionals (center manager,

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veterinary officer and technical assistants) who are appropriately trained in international bustard breeding facilities, with the guidance of visiting bustard breeding expert(s). Additional funds will be acquired to sponsor the international training trips of these officers. A detailed action plan will be developed in consultation with the visiting bustard breeding expert(s) in the first two years of the project. The facility will be run till a self-sustaining founder population has been established, which might take 25-30 years. Subsequently, captive-bred birds will be released into the restored habitats of Gujarat, Maharashtra, and Rajasthan, following scientific release protocols between 30-35 years. This project entails the first implementation phase of the conservation breeding program, and the budget including the contracts and salaries of the center staff will be revised at the end of this phase.

Activity 2: Applied research

The following research activities are essential to guide where, how and what in-situ management measures should be implemented for judicious investment of conservation funds.

2a) Population and habitat surveys

Existing and potential bustard habitats will be identified for conservation management and their status will be monitored for objective assessment of management effectiveness. The project proposes population and habitat status evaluation surveys for both endangered bustards inhabiting semiarid grasslands - the GIB and lesser florican. Two-phase surveys will be conducted by the research team in collaboration with Forest Department frontline staff to generate baseline information (2016-17) and detect changes (2020-21). These surveys will generate spatially explicit information on species' occupancy and abundance along with habitat status. A survey protocol based on line transect distance sampling and occupancy analysis (Buckland et al. 2004, Mackenzie et al. 2006) has been developed by Dutta et al. (2015) that can be further refined to achieve replication across other landscapes.

2b) Ranging patterns using biotelemetry

Landscape use patterns of bustards will be studied by satellite telemetry on 6-12 GIB (2-4 each in Rajasthan, Gujarat, and Maharashtra landscapes) and 4-8 lesser florican for 4-5 years. Birds will be captured using foot noose and fitted with 70gm (GIB) and 5 gm (lesser florican) solar GPS PTTs for transmitting location information to remote computers. This data can be analyzed with remotely sensed and field collected ecological variables (e.g., land cover, disturbance, topography, and food) to understand space use patterns. This activity will provide crucial information on seasonal movements, critical resources, relationships with human disturbances and connectivity between landscapes.

2c) Assessment of threats and livelihood concerns

For judicious utilization of conservation funds to mitigate threats at landscape-level, research teams will characterize the spatial distribution of power-lines, pesticide-prevalence and dog-densities. Spatial risk maps will be generated from the overlapping distribution of birds and these threats (see activity 3c).

For reconciling resource dependency of local communities and conservation goals, research teams will conduct sociological surveys to assess stakeholders' dependency on bustard habitats and their

perceptions regarding bustard conservation (Marshall et al. 2010). Agro-pastoral households will be sensitized on ecological hazards of inorganic farming and livestock overgrazing through mobile workshops and documentary films in collaboration with partner NGOs (see activity 4b-2). Subsequently, the willingness of agro-pastoralists to adopt bustard-friendly practices will be assessed based on choice experiments. Combinations of financial incentives like compensation, resource supplementation, relocation and alternate livelihoods will be provided for pursuing organic farming, reduced cropping, stall-feeding of livestock during monsoon or reduced stock size (Harihar et al. 2015). We will also include local communities' knowledge in land use planning through Participatory Rural Appraisals (Chambers 1994).

2d) Conservation genetics

Great Indian bustard and lesser florican feces and feathers will be collected systematically across each landscape during population/habitat surveys, dried, stored in plastic bags with silica crystals, and transported to WII laboratory at the earliest. DNA will be extracted from these samples using modified Qiagen tissue kit or Guanidinium thiocyanate method (Boom et al. 1990). DNA will be amplified using Polymerase Chain Reaction (PCR), with mitochondrial DNA markers and nuclear microsatellite markers, which have been used in other endangered bustard species. Individual-level data, thus generated, will be analyzed to a) estimate abundances of local populations in a spatial capture-recapture framework (Efford and Fewster 2013, Moore and Vigilant 2014); b) assess migration rates and patterns (differences between genders, landscapes etc.) between landscapes using a full likelihood and bayesian coalescence based computation analysis of genetic partitioning (Beerli and Felsenstein 1999, Hey and Nielsen 2007); c) estimate population parameters, including diversity statistics (Excoffier et al. 2005) and effective population size, using a likelihood analysis with Metropolis algorithm using random coalescence based method (Kunher 2006); d) determine phylogeographic structure using a bayesian phylogenetic analysis (Drummond and Rambaut 2007); e) identify geological and ecological processes influencing phylogeographic structure using coalescence based analysis in an approximate bayesian computation framework (Cornuet et al. 2008, Lopes et al. 2009, Wegmann et al. 2010, Lopes and Beaumont 2010); f) characterize population bottlenecks using tests of mutation-drift equilibrium with allele frequency data or coalescence based models (Piry et al. 1999, Cornuet et al. 2008); and g) compare genetic composition of captive stock with respect to the wild population based on genetic diversities (Excoffier et al. 2005) and population structures (Pritchard et al. 2000, Corander et al. 2008).

Activity 3: Capacity building and awareness

3a) Improving management enforcement

To enable real-time monitoring of illicit activities across vast GIB landscapes, a technology aided patrolling framework will be developed and implemented through frontline staff of Forest Department in conjunction with local people on the lines of MSTrIPES (Jhala et al. 2011). This activity entails developing tools (equipment, software and platform) that can be used by patrolling teams to collect information on ecological (species and habitat status) and management (poaching, land use conversion

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etc.) parameters. These information will be collated in a central database that will generate statistics and maps on spatial and temporal trends of these parameters to guide management decisions spontaneously. Research teams will train frontline staff of each state on the application of this tool during routine activities. This tool can also be used for assessing staff performance and providing incentives so as to improve protection enforcement. Attempts will be made to sensitize local youth on bustard conservation through our partner NGOs with the formation of clubs such as 'Friends of Bustard'. Sensitized people can be eventually engaged in patrolling activity through appropriate training by our research team on technology aided patrolling. Additionally, we will explore the possibility of supplementing enforcement with the use of Unmanned Aerial Vehicles. These 'Conservation Drones' are relatively inexpensive (~1 lakh INR), can fly across 25 km for 50 minutes while taking high-resolution aerial photographs that can be analyzed to map land-cover, monitor illicit activities and birds, and have immense potential in ecological monitoring (Koh and Wich 2012).

3b) Stakeholder sensitization

1) Research teams will identify key stakeholders of bustard landscapes and initiate informal meetings with them. Representatives from various stakeholder groups (decision-making and implementing officers in public/private agencies and local community members) will be invited to participate in workshops where they will be sensitized on bustard conservation issues. One 2-day workshops will be organized in each State, once every year, with the capacity of 10-20 participants. Workshops will be conducted by subject experts and local figures, and will include 'reality check' visits to bustard habitats.

2) To promote bustard-friendly practices in priority conservation areas, mobile workshops will be conducted in select villages by the research team and expert resource persons. These workshops would sensitize local land-users and encourage them to support bustard conservation (see activity 2c).

3c) Raising public awareness and support

To raise general awareness on bustard conservation issues, we will involve expert consultants for developing and distributing: a) publicity posters in educational and marketplaces in/adjoining bustard habitats; b) publicity boards in prominent places in/adjoining bustard habitats; and c) promotional documentary film on the need, challenges and efforts for bustard conservation featuring national and local celebrities (actors, sportsperson and spiritual gurus). The film will be uploaded on social network and aired in television channels for wider outreach and advocacy.

Activity 4: Pilot implementations of surgical habitat management

4a) Strategic land acquisition/rationalization

Areas intensively used by GIB for breeding and critical non-breeding activities will be identified through population surveys and radio-telemetry (see activity 2a-b). The ownership and extent of these lands will be mapped from Revenue and Forest Department documents and ground validation surveys. Critical lands owned by Revenue Department will be proposed for transfer to Forest Department. In case of private/community-owned lands, research teams will sensitize target land-owners about GIB

conservation and assess their willingness to sell lands. State Forest Departments will be encouraged to utilize State CAMPA funds for purchasing these private lands. A multi-criteria decision framework incorporating this information will be used to prioritize lands for acquisition by Forest Department. Relatively large and contiguous unprotected lands, which have high conservation value but pose practical problems against acquisition, will be proposed for declaration as Community/Conservation Reserves (Section 31A of Wildlife (Protection) Amendment Act 2002 (2003). In the process, some areas within Sanctuary expanses might be identified as poor wildlife habitat, and would be rationalized to alleviate local people from the legal restrictions on subsistence activities. These processes have already been initiated in Thar, Kachchh and Solapur landscapes by various agencies and need to be concluded.

4b) Breeding enclosure management

Priority GIB breeding enclosures (e.g., Sam-Sudasari, Ramdeora and Lala-Naliya) would be selected for experimental management with the paramount objective of improving bustard breeding success:

1) A predator- and livestock- proof chain-link fence (6 feet above ground, angled outside with barbed wires, and 1 feet below ground) would be laid around enclosures, each covering >10sqkm area. The required funds will be transferred to the Civil Construction Unit or to the respective State Forest Departments for undertaking these construction activities. Research teams would subsequently monitor the effectiveness of the fence in preventing undesired species from trespassing using signs/camera-traps.

2) Research teams would assess the status of nest predators (e.g., foxes, mongooses, monitor lizards, wild pigs and dogs) inside enclosures using camera-traps. The potential impact of these predators on ground-nesting birds would be assessed using dummy nests accessorized with camera-traps. On a need-basis, these predators would be trapped and released in suitable habitat outside the enclosure following scientific protocols and appropriate permits.

3) Food plants of GIB like alfalfa/lucerne *Medicago sativa* and chickpeas /gram *Cicer arietinum* will be cultivated organically in a few plots not exceeding a total of 1 ha area to increase food resources for birds. This activity of growing food crops will be restricted to one portion of the enclosure and completed before the onset of breeding season to minimize disturbance. Their effectiveness would be monitored by comparing bustard usage of these locations with that of random locations. If these practices yield favorable results, then State CAMPA funds can be utilized to replicate them elsewhere.

4c) Mitigating critical threats

1) To mitigate the detrimental effects of power-lines, research teams will map the spatial risk of bustard collision with power-lines by integrating information on electricity network (activity 2d), ranging patterns (activity 2b), and intensity of habitat use (activity 2a) following Silva et al. (2014). Based on the risk map, we will prioritize power-lines for the following actions: making overhead power lines underground in high-risk areas and marking power-lines with Bird Diverters in moderate-risk areas.

2) Abundance and ranging patterns of dogs will be assessed using mark-resight method and GPS data-loggers to map the spatial risk of wildlife encounter with dogs (Matthews et al. 2008). Large-scale scientific dog sterilization programme would be undertaken in priority areas by involving expert

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agencies like the Corbett Foundation and Human Society International. The effectiveness of this action would be monitored in terms of dog population trends in subsequent years.

3) Pesticide prevalence in bustard food and physiology will be assessed following Tanabe et al. (1998) from spatially representative samples of GIB and lesser florican fecal/feather and food samples. Areas where agricultural use of pesticides has to be reduced will be identified from a spatial risk map generated by overlapping the distribution of birds and pesticide prevalence. State Forest Departments and allied agencies (e.g., State Pollution Board and Agricultural Department) will be encouraged to provide financial incentives (Agro-environmental Incentive Schemes) to farmers for opting for organic farming in these priority areas. To demonstrate the pros and cons of such investment, National CAMPA funds will be utilized for pilot implementation of these agro-environmental incentive schemes in a small area of few square kilometers within the priority bustard habitat of each State.

5. Outcomes

- **Activities related to conservation breeding** will result in:

1. A functional breeding center in 5 years; and
2. A self-sustaining captive population of bustard as insurance against extinction in future.

- **Activities related to applied research** will result in:

1. A standardized protocol to monitor population/habitat status and assess management effectiveness;
2. Prioritization of conservation areas within bustard landscapes for land use planning;
3. Spatial risk maps of critical threats for judicious allocation of mitigation measures;
4. Understanding of livelihood concerns and scope of implementing bustard-friendly land uses to identify mechanisms that can balance conservation and livelihood needs; and
5. Comprehensive understanding of the past and present genetic scenarios of bustard populations and their causal processes to identify factors limiting species' recovery.

- **Activities related to capacity building and awareness** will result in:

1. Intensification of protection enforcement and spontaneous management of threats;
2. Sensitization of stakeholders (decision-makers and local people) about bustard conservation;
3. Community engagement in conservation; and
3. Increased public awareness and support for bustard conservation.

- **Activities related to pilot implementations of surgical habitat management** will aid in:

1. Identifying strategic lands for acquisition and revision of Protected Area expanse for effective conservation enforcements;
2. Demonstrating best practices for managing breeding enclosures; and
3. Mitigating critical threats in priority bustard habitats, such as reduction of dog numbers, overhead unmarked power lines and pesticide prevalence.

Log-frame

Goal	Actions	Approaches	Assumptions	Outputs	Timeframe	Monitoring indicators & time	Risks
Securing a captive population as insurance against extinction	Conservation breeding	Collection of wild eggs from Rajasthan; artificial incubation of eggs, rearing of chicks & adult birds to form a captive breeding population of GIB & (if needed) lesser florican in Gujarat	Mutual agreement & cooperation between partners (State Governments of Gujarat & Rajasthan & MoEFFCC), permits of egg collection & construction of breeding centers	Functional captive breeding facility	1-5 years	Laying & construction of basic facilities in 2 years	Obstacles in agreement & cooperation between partners, unavailability of wild eggs due to poor rainfall & other stochastic events that can reduce production in captivity
						Initiation of artificial incubation on 3rd year	
						Addition of birds in captivity from artificially incubated eggs on 5th year	
				Development of captive breeding population	10-25 years *	Initiation of reproduction in captivity on 15th year	
					25-30 years *	Formation of founder population in captivity on 30th year	
				Reintroduction of captive birds	30-35 years *	Initiation of site selection & reintroduction	
Recovery of wild population & improvement of habitats	Applied research	Satellite telemetry	Permits related to tagging of birds & import/use of telemetry equipment	Prioritization of conservation areas	1-5 years	Tagging of 3 GIB by 2nd year & 6 GIB by 3rd year	Delay in permits & loss of tags
						Satellite data acquisition of >1 year by 4th year	
						Report on spatial prioritization on 5th year	
		Population/habitat surveys - line transect & habitat plots	Research permits, cooperation & infrastructure of State Forest Department	Baseline estimates of population & habitat status	1-5 years	Status survey reports on 2nd year	Inadequate statistical power to detect population trends due to rarity of birds
				Preliminary assessment of management effectiveness	1-5 years	Status survey report on 5th year	
		Characterization of threats to guide threat mitigation	Coarse-scale understanding of bustard occupied areas	Threat maps (power-lines, pesticides & dogs)	1-5 years	Threat assessment report on 5th year	Future shifts in distribution of threats
		Social surveys & appraisals	Coarse-scale understanding of bustard occupied areas	Understanding of local communities' resource dependency, conservation attitude & willingness to adopt sustainable landuses	2-4 years	Social survey reports on 4th year	
	Pilot surgical habitat management	Breeding enclosure management (fencing, predator-removal & food provision)	Cooperation & facilitation of management actions by Forest Department	Demonstration of best-practices for managing breeding enclosures	1-3 years	Improved recruitment rate of birds based on dummy nest experiments on 3rd year	Lapse in motivation & non-sustenance of practices beyond project period
		Mitigating critical threats in priority areas	Fine-scale information on priority bustard habitats & cooperation of relevant agencies	Marking of power-lines & population control of dogs in priority bustard habitats	1-5 years	Reduction of threats in priority bustard habitats based on reports before (2nd year) & after (5th year) the implementation	Lack of support from power corporations & local people
		Surveys to identify lands for strategic acquisition & rationalization	Fine-scale information on priority bustard habitats	Revision of Protected Area expanse to improve management & reduce antagonism	2-4 years	Report on land identification for acquisition/rationalization on 4th year	Lapse in Government will & inadequate funds to acquire lands
Stakeholder engagement in	Capacity-building &	Implementation of technology aided	Logistic support & facilitation of Forest	Regular & systematic collation of ecological/	1-3 years	Patrolling information database & reduced time-lag in management interventions on 3rd year	Lapse in motivation & non-sustenance of

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Goal	Action	Approach	Pre-requisites / Assumptions	Output	Implementation Time	Monitoring Indicators & time	Risks
conservation	awareness	patrolling through technology & incentives	Department for implementing program	management information to guide management			activity beyond project period
		Workshops to train forest officers	Formulation of coursework & publication materials in collaboration with experts	Improvement of management skills	1-5 years	Officer training assessment reports every year	Non-cooperation of Forest Departments
		Workshops to sensitize non-forest officers		Sensitization of decision-makers & to plan landuses as if conservation matters	1-5 years	Positive conservation attitude of officers based on feedback reports every year	Non-cooperation of other departments & agencies
		Mobile workshops to sensitize local people		This activity will promote conservation support & sustainable landuses	1-5 years	Positive change in conservation attitude of local communities based on social surveys before (2nd year) & after (5th year) workshops	
		Production & distribution of publicity materials		Public awareness about bustards & their conservation significance	2-4 years	Positive change in knowledge about bustards based on social surveys before (2nd year) & after (4th year) publicity campaigns	
	Promoting bustard-friendly landuses	Pilot implementation of compensation schemes to incentivize bustard-friendly landuses in priority conservation areas	Fine-scale information on priority bustard habitats	Increased crop-area under , organic farming & reduction in livestock grazing during breeding season in pilot implementation areas	3-5 years	Reduction in pesticide usage & increase in herbaceous cover in implementation areas on 5th year	Lapse in liaising & funding support for replicating this activity beyond project period & other priority areas

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Budget (Amount in Lakhs INR)

Head	Particulars	Yr 1	Yr 2	Yr 3	Yr 4	Yr 5	Total
Staff engagement	3 Project Scientists (1 CBC + 1 vet + 1 field)	20.16	22.18	24.39	26.83	29.52	123.08
	2 Project Associates (field)	10.85	11.93	13.13	14.44	15.88	66.23
	4 Project Assistant grade 2 (2 CBC + 2 field)	9.60	10.56	11.62	12.78	14.06	58.61
	4 Project Assistant grade 1 (1 CBC + 3 field)	7.30	8.03	8.83	9.71	10.68	44.54
	8 Field assistant grade 2 (5 CBC + 3 field)	10.08	11.09	12.20	13.42	14.76	61.54
	3 Field assistant grade 1 (field)	2.88	3.17	3.48	3.83	4.22	17.58
	Daily labour in field & CBC	3.06	3.37	3.70	4.07	4.48	18.68
	Project Management Unit (part cost)	15.36	13.65	14.80	16.05	17.43	77.29
	Total costs of staff engagement	79.28	83.96	92.15	101.14	111.02	467.55
Conservation Breeding	Center establishment costs	414.00	270.00	225.00	90.00	90.00	1089.00
	Center running costs	14.85	39.85	41.84	41.84	43.84	182.22
	Center maintenance costs	0.00	0.00	4.50	22.50	22.50	49.50
	Miscellaneous costs (training, collaboration & contingency)	47.44	36.49	18.82	15.07	15.52	133.34
	Total costs of conservation breeding	476.29	346.34	290.16	169.41	171.85	1454.06
Applied research	Satellite telemetry costs (PTT & trapping costs)	33.34	52.09	16.05	14.85	15.53	131.86
	Threat assessment surveys (vehicle charges)	13.50	13.50	14.85	14.85	15.53	72.23
	Population/habitat surveys (honorarium, vehicle, accommodation & tools – GPS & binocs)	18.43	3.00	0.00	0.00	24.64	46.06
	Surveys for land acquistion/rationalization, social aspects & other species status	0.00	5.40	5.94	5.94	0.00	17.28
	General field equipment (camera traps, laptops, cameras, accessories & stationary)	17.70	2.07	2.28	2.28	2.38	26.70
	Accommodation & travel	7.92	7.92	8.53	8.72	9.14	42.23
	Research/conservation laboratory (genetics & pesticides): equipment (part cost) & analysis charges	58.35	13.35	14.69	14.69	34.82	135.89
	Contingency (collaborative service charges & miscellaneous)	10.46	7.87	6.42	6.37	8.55	39.66
	Total costs of applied research	159.70	105.20	68.75	67.69	110.58	511.92
Capacity-building & awareness	Training of Forest/Conservation Staff (wildlife specialization & other trainings)	0.00	20.00	21.00	21.00	23.00	85.00
	Technology aided patrolling (developing tools, conducting training workshops for implementation & equipments)	13.14	17.14	13.35	4.40	4.60	52.63
	Workshops to sensitize non-forest officers (materials, travel & accommodation) – 3 workshops/yr & 15 participants/workshop	8.94	8.94	9.83	9.83	10.28	47.83
	Mobile workshops to sensitize local people (equipment, materials, travel & logistics) – 15 villages/yr & ~500 people/yr	4.00	3.60	3.96	3.96	4.14	19.66
	Awareness materials (posters, boards & documentary film)	0.40	7.40	8.14	2.20	0.00	18.14
	Contingency (collaborative services & miscellaneous)	6.32	7.85	8.31	7.57	7.85	37.91
	Total costs of capacity-building & awareness	32.80	64.93	64.60	48.95	49.87	261.18
Pilot habitat management	Predator-proof-fencing in critical enclosures	108.00	144.00	0.00	0.00	0.00	252.00
	Predator population management (traps, drugs, darting guns & neutering costs)	43.00	24.00	24.00	4.00	0.00	95.00
	Marking power-lines with Bird Diverters	91.00	0.00	0.00	68.25	68.25	227.50
	Agro-environmental Incentives & food provisioning in enclosures	5.00	5.00	53.00	53.00	0.00	116.00
	Total costs of pilot implementation of habitat management	247.00	173.00	77.00	125.25	68.25	690.50
	TOTAL	995.08	773.44	592.66	512.45	511.57	3385.20

CBC = Conservation Breeding Center

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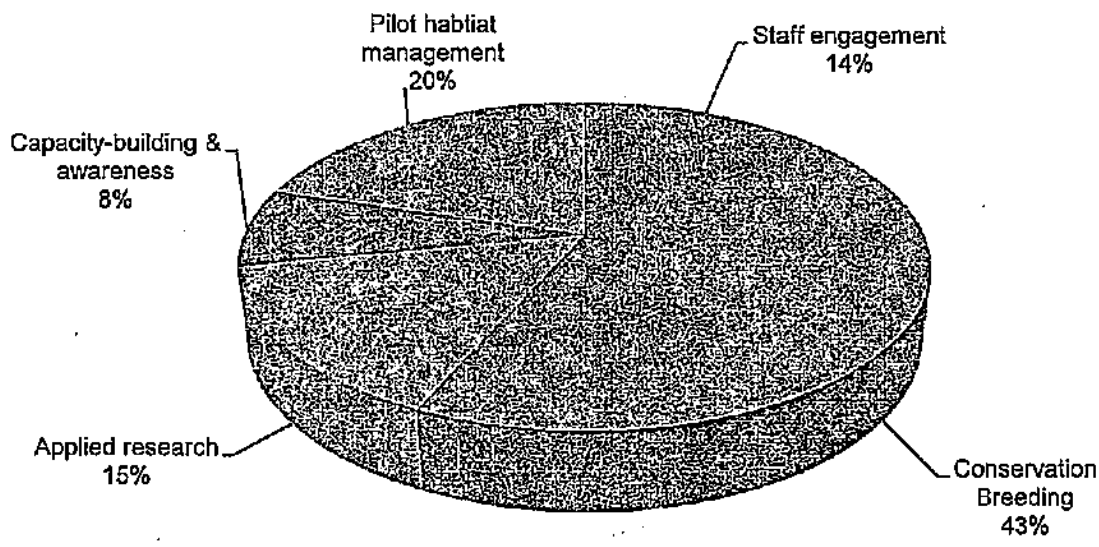
Summary table (Amount in Lakhs INR)

Head	Year 1	Year 2	Year 3	Year 4	Year 5	Total
Staff engagement	79.28	83.96	92.15	101.14	111.02	467.55
Conservation Breeding	476.29	346.34	290.16	169.41	171.85	1454.06
Applied research	159.70	105.20	68.75	67.69	110.58	511.92
Capacity-building & awareness	32.80	64.93	64.60	48.96	49.87	261.18
Pilot habitat management	247.00	173.00	77.00	125.25	68.25	690.50
Total	995.08	773.44	592.66	512.45	511.57	3385.20

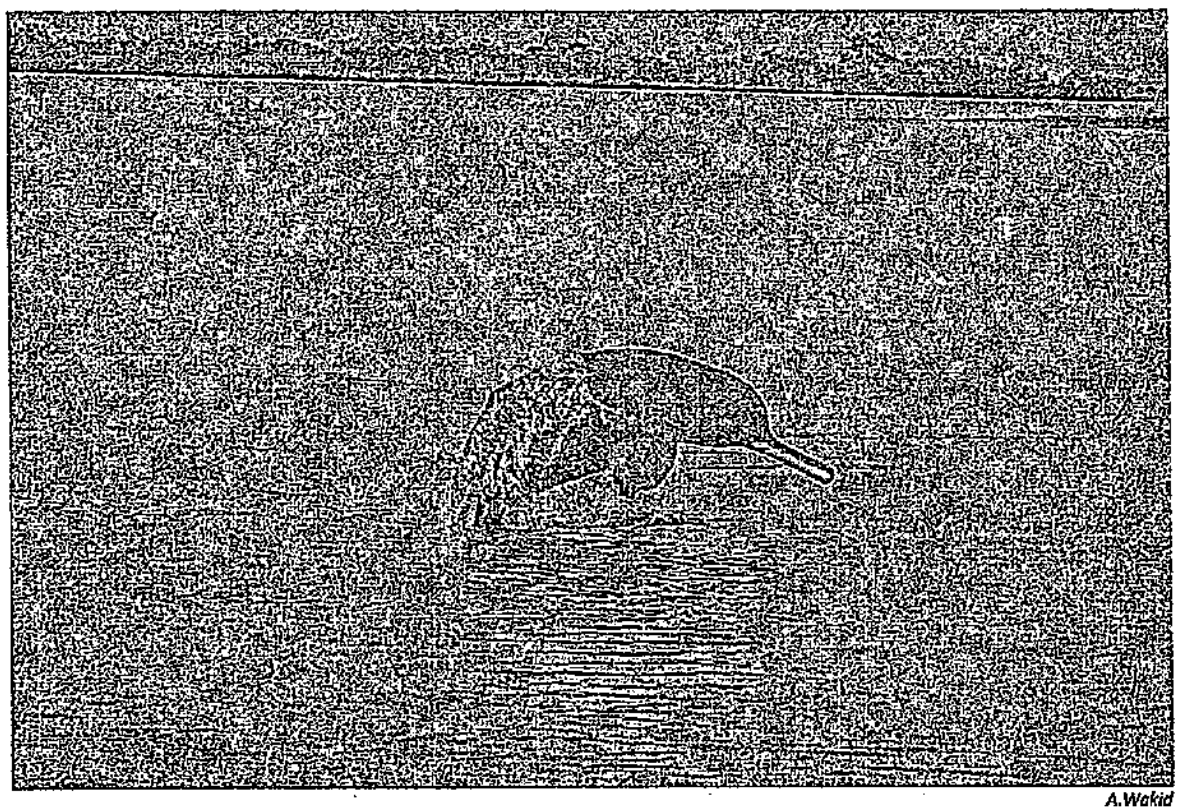
Pie-chart showing budget-allocation for various project activities



** 32% of the budget (Rs. 1089 lakhs) has been allocated for establishing the Conservation Breeding Centers – main & satellite facilities. The estimated costs include: (a) construction of a predator-proof enclosures around 4.5 km^2 area that have been sanctioned for the centers (12 km perimeter) @ Rs. 1,200,000/km = Rs. 144 lakhs; (b) construction of buildings (office, staff quarters, store & egg/food/chick chambers) with furniture in 600 m^2 space @ Rs. 50,000/m^2 = Rs. 300 lakhs; (c) construction of pens (separate for juvenile, adult & quarantine birds) in 9000 m^2 area @ Rs. 2500/m^2 = Rs. 225 lakhs; (d) breeding facilities (infrastructure, equipment, electrical/electronic appliances etc.) at two centers @ Rs. 120 lakhs; (e) uninterrupted water, security, power facilities at two centers @ Rs. 120 lakhs; and (f) modification costs of enclosures, buildings, facilities & infrastructure to accommodate more birds & unforeseen situations @ Rs. 180 lakhs.

Annexure-II

Development of Conservation Action Plan for River dolphins *(Platanista gangetica gangetica)*



A.Wakid

Implementing Agency	:	**Wildlife Institute of India**
Project Partners	:	**State Forest Departments of Bihar, Uttar Pradesh, Assam, West Bengal, Madhya Pradesh, ARANYAK,WWF, Patna University, Bhagalpur University and Indra Prastha Institute of Information Technology (Delhi)**
Project Cost	:	**23.0 Crore**
Project Duration	:	**2015 – 2020**

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PROJECT BACKGROUND

India's National Aquatic Animal, Gangetic dolphin (*Platanista gangetica gangetica*), is restricted to the Ganges-Brahmaputra-Meghna and Karnaphuli river systems of India, Nepal and Bangladesh (Jones, 1982; Sinha, 1997). Ganges dolphin is locally known as *Susu* in North India and *Hihu* in Assam. IUCN listed the Gangetic dolphin as Endangered in 2004 as its population has declined by more than 50%, and the decline is expected to continue. In 2008, the dolphin was declared as the State aquatic animal of Assam and in 2009 as National aquatic animal. The Gangetic dolphin now receives the highest level of protection available in India as a Schedule-I Species listed under the Wildlife Protection Act 1972.

Smith et al (2011) estimated the minimum population of Gangetic dolphin as 1200-1800. In Bangladesh, Ganges dolphins occur in Jamuna River, Kushiyara River, Burhi-Ganga. Karnaphuli–Sangu River system and in Sundarbans (Fig1). In Nepal, it occurs in Karnali River (from Kachali to Kotiaghat), Saptakoshi river (confluence of Arun and Sun Koshi to Kosi Barrage), Narayani river (Devghat to Triveni Barrage (Fig 1). In India it occurs in Ganga (Bijnour to Farrkka) and its tributaries like Yamuna (from Hamirpur down stream), Ken (from confluence of Yamuna at Chilla to Sindhan Kala village) , Betwa (from confluence of the Yamuna to Orai), Sind, Kosi (Kosi Barrage to Kursela), Gandak, Gerua (from India- Nepal border to Girijapuri Barrage), Sharda, Son and in Brahmaputra river (Assam-Arunachal border to India-Bangladesh border) and its tributraries such as Kulsi and Subansiri (Fig 1) (??Smith et al 2011,Wakid et al 2012).

There is a drastic decrease in the distribution range of the species within last few decades. In Ganges, the species distribution range was declined by about 100 kms since late 1800 (Smith et al, 2004). In Yamuna River, the species was distributed upto Delhi (Anderson, 1879), but now the distribution is restricted much more downstream. Like-wise, once occurring in reservoir behind the Kaptai dam of the Karnaphuli-Sangu system (Ahmed 2000), the species is now completely declined from there. In Brahmaputra river system within India also, the population distribution range has been declining very rapidly within last 5 decades, especially from the tributaries of Brahmaputra River (Wakid, 2009). Anthropogenic disturbances are the main cause of this dramatic population decline. Water development projects, especially dams and barrages, pollution, deliberate killing for oil, accidental killing through fishing nets are the major man-made causes of the population decline. Several key categories of potential threat are: (a) fragmentation of the dolphin habitat, (b) reduction or elimination of habitat simply in terms of dry-season flow, (c) "escapement" of dolphins into canals where they are unlikely to be able to get back into rivers and are therefore

doomed, (d) cascading effects from interrupted migrations of prey organisms, degradation of prey spawning habitat and overharvesting of fish (e) contaminant flux leading to significant changes in chronic and/or acute exposure to toxins, (f) loss of complexity (channelization, sediment entrapment), (g) making the rivers less habitable for dolphins due to mining and developmental works, and (g) agricultural runoffs of fertilizers and pesticides.

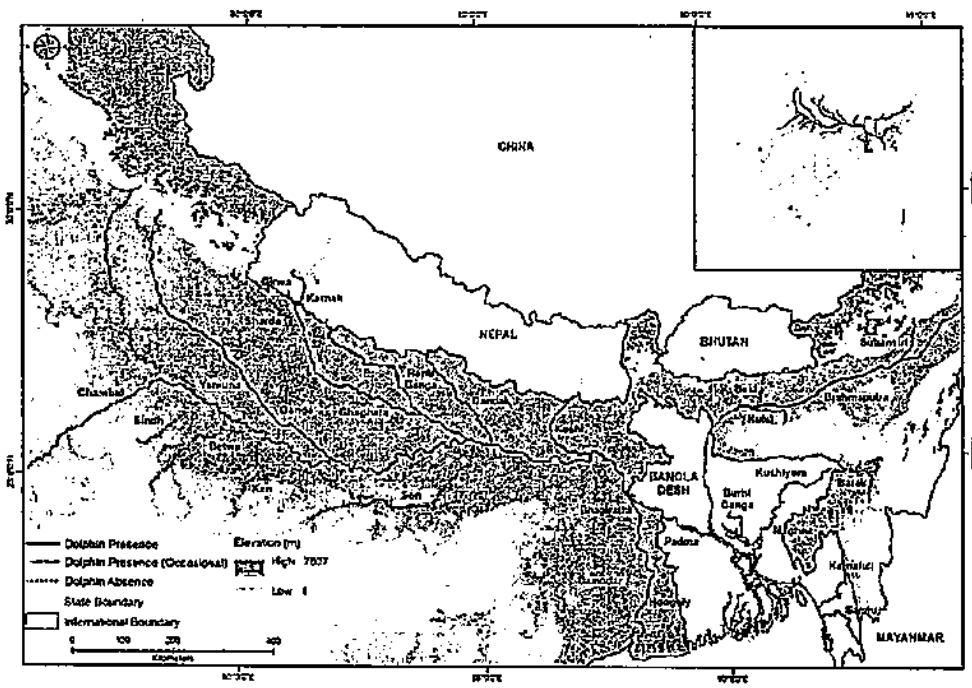

Fig 1: Distribution of Gangetic dolphin in Ganga, Brahmaputra and Karnaphuli-sangu river systems.

The Ganges river dolphin is almost blind and can live in freshwater with small population living in low salinity estuarine areas. They emit ultrasonic sounds to prey on fish and detect other objects under water. They are solitary seldom found in small groups, generally a mother and calf seen together. Females are larger than males and give birth once every two to three years to only one calf. Ganges dolphin reproduces at the age of 6–10 years and maximum longevity may be close to 30 years (Sinha 1997). Ganges River dolphins are generally concentrated in counter-current pools below channel convergences and sharp meanders and above and below mid-channel islands, bridge pilings, and other engineering structures that cause scouring (Sinha 1997,Smith 2011 Wakid 2012). Their fidelity to counter-current pools is probably greatest in fast flowing channels. Annual monsoon floods cause great variability in the dolphins' access to large parts of their range. Isolation in seasonal lakes sometimes occurs, as does "escapement" from the river channels into artificial water bodies such as canals and

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reservoirs. Ganges River dolphins are not generally known to occur in salinities greater than 10 ppt, although they have been recorded in waters as saline as 23 ppt.

Little is known about its ranging pattern, behaviour and resource utilization due to difficulties in underwater studies. With recent technological advances in underwater photography, sound recording and several other sensors available to assist in collection of important ecological information, it will be easier to address the paucity of information.

GOAL AND OBJECTIVES

Dolphin is indicator of river quality, not only for river ecosystem integrity but also for sustenance of humans. To keep our river system healthy we need to conserve dolphins and monitor it as indicator of river health. Therefore, this program aims to develop recovery plan for the Gangetic dolphin populations and their habitats in India. This program also aims to develop Ganga and Brahmaputra river monitoring system with dolphin as flagship species. The program will also engage people dependent on river specifically fisher folk, and other water dependent profession and industries.

The project has following aims:

1) Recovery plan of Gangetic dolphins and their habitats in India.
2) Engagement of stakeholders in conservation of River Ecosystems in India.

The main objective of this projects are :

1) To develop monitoring protocol for dolphins.

2) Status of associated river fauna like Gharial, Otter, Tutrtles and Fishes.

3) Quality assessment of river habitat in terms of water quality, anthropogenic pressure and landscape surrounding riverscape.

4) Evaluate the current status of invasive species in riversacpe.

5) Involve stake holders to develop a network which will assist in dolphin conservation.

The project envisage to fill in the gaps of current knowledge about ecology of dolphin and riverscape. Stake holders will involve fishermen, agriculturists and industry dependent on river system for their sustenance and objective of the study is how their practices can be made least destructive for riverscape conservation.

SCOPE OF WORK

The main aim of the plan is the recovery of the declining Gangetic dolphin populations and improving its habitat. Under this broad aim the plan has following specific actions.

Research

- Status Survey and long term monitoring of Gangetic dolphin, associated river fauna and their habitat in India using advanced technique.
- Identification and mapping of threats and critical habitat of Gangetic dolphin in India.
- Ecology of Gangetic dolphin in India.
- Genetic study to identify meta-population structure and genetic diversity.
- Develop protocol and procedure for dolphin rescue and rehabilitation.

Conservation Action

- Develop awareness for conservation of Gangetic dolphin and its habitat.
- Promoting participatory management of Gangetic dolphin and their habitats by mainstreaming the dolphin conservation into production sectors such as Hydro-electric projects, Oil sector, Fisheries, Irrigation etc.
- Reduce direct and indirect causes of Gangetic dolphin mortality.
- Identify, conserve, manage and restore critical habitats of Gangetic dolphin habitats in India.
- Develop rescue centre for temporary holding for dolphins.

Capacity Building

- Enhance capacity of concerned stakeholders in participatory management of dolphins and their habitats.
- Enhance capacity of concerned stakeholders towards use of advance technology in monitoring and management of dolphins and their habitats. Develop capability in rescue, rehabilitation and disease investigation

APROACH AND METHODOLOGIES

Research

Status Survey and long term monitoring: A comprehensive review of the dolphin survey methods that were followed by earlier studies (Mohan et al., 1997; Biswas & Baruah 2000; Smith & Reeves 2000; Wakid 2009; Braulik 2006, Wakid & Braulik 2009; Baruah et al. 2012, Vidal 1997; Smith et al 2006; Dawson et al 2008; Zhao et al 2008) were reviewed extensively and Wakid et al (2012) survey method was found to be suitable for dolphin survey. This method involve Mark- recapture based line transect survey in conjunction with use of hydrophones based detections. In areas where large

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boats can be used, two decks were used for two observer teams to do independent observation. In places where water will be shallow, two flat bottom or country boats in tandem will be used as two observers for survey. Regarding group size, except for mother- young pairs, the motivation for individual Ganges river dolphins to form "group" appears to be the common use of habitat, defined by hydrology and geomorphic features, rather than obvious social affiliations (Smith 1993, Smith *et al.* 1998, 2001). During the survey, group was defined as individuals seen with close proximity of each other.

In conjunction with the boat based visual survey of dolphins, we also conduct acoustic survey of dolphin to reduce the sighting bias in visual survey which may occur due to the dolphin behaviour. The acoustic survey was conducted using hydrophones (A_tags). Two stereo acoustic data loggers will be towed behind the boat to detect dolphins.

The other important fauna like gharial, turtles, otters and fishes will be monitored using, line transect, mark-resight, and catch per unit effort (Talwar and Jhingran 1991, Wakid, 2012). The habitat quality will be recorded at every km and at each sighting of species of interest.

Monitoring for entire stretch of Ganga and Brahmaputra will be done on annual or biannual basis, with important stretches being monitored on annual basis. The monitoring will be done by concerned forest department with assistance from local Institution (Institute, University or NGO/NGI)

Monitoring and mapping of habitat and threats: The anthropogenic activity like use of banks for human activities, fisherman, type of fishing activity, waste disposal by people and industrial waste disposal points will be recorded. Water samples will be collected at every 1 or 5 km depending on intensity of use of sector by people or industry for water quality and pollutant monitoring. Fish and sediments will also be collected at regular interval for pollutant monitoring.

Water depth, current and width of river at sampling point will be recorded. For water quality analysis YSI handhold professional multi-parameter equipment will be used and samples will also preserved for detail laboratory monitoring. The water quality equipment will be set up to automatically log water quality data at 1 km interval. Following parameters were recorded by this equipment; Temperature (in ^{0}C), pH , dissolved oxygen (in % L and mg/L), total dissolved solid (in mg/l), salinity (in ppt) and Pressure (in mmHg). Along with the above-mentioned water quality parameters, we also analyse turbidity (by Turbidity Meter), Ammonia (by YSI photometer), Nitrate

(by YSI photometer), Nitrite (by YSI photometer) and Phosphate (by YSI photometer). The preserved water samples and tissue samples from fish and dolphin (from dead dolphins) will be analysed for pollutants specifically pesticides, heavy metals and other harmful chemicals which may affect reproduction in dolphins.

The Ganga and Brahmaputra river system will be mapped and change of river character for dolphin and associated fauna will be assessed. We will map the river and surrounding 2 km area for change in geomorphology and land use using supervised and unsupervised classification (Jenson 1996). We will use MODIS, AWiFS, Landsat, IRS, and Quickbird digital satellite data for mapping.

Ecology of dolphin: Little is known about feeding ecology, habitat use and demography of this species due to nature of habitat. We will study the habitat use and resource utilization on trial basis at select high density area using under water vehicle (with remote cameras and sensors), fish finders, underwater camera traps and radio telemetry. If the experiment will provide meaningful data we will extend this in areas important for dolphin conservation. We will also address the resource partitioning between dolphin and other aquatic predators like gharial, otters and crocodiles.

Genetic study is needed to understand the existing spatially structured genetic diversity, the presence of population bottlenecks, population demography and the female effective population size. The tissue samples will be collected from carcass as well as those available with different organizations. All samples will be preserved in 70% ethanol and stored at –20°C for subsequent analysis. We will use polymerase chain reaction (PCR) to amplify mitochondrial (mtDNA) sequences of the control region and cytochromeb (Dalebout et al. 1998). PCR products will be purified using QIAquick PCR purification kit (Qiagen). Nuclear DNA will be amplified using microsatellite markers be selected on the basis of previous cetacean studies (Hamilton et al 2001, Oremus et al 2007). To understand the genetic diversity and female effective population size, the mtDNA sequences will be aligned and assembled using SEQUENCHER v. 4.6 (GeneCodes, Ann Arbor,Michigan). Estimation of genetic diversity and other population parameters like measures of nucleotide diversity (p), haplotype diversity (h), Tajima's neutrality test (Tajima 1989), and mismatch distribution testing for demographic expansion, equilibrium or bottleneck (Rogers and Harpending 1992), will be computed using the program DnaSP v. 5.10 (Librado and Rozas 2009). We will determine the degree of genetic structuring by examining an unrooted phylogenetic network described by Bandelt et al. (1999), using the software NETWORK v. 4.5.1 (http:// www. fluxusengineering. com). We will estimate effective female population size using LAMARC v. 2.1.3 (Beerli and Felsenstein 1999, Kuhner 2006, Ishtiaq et al 2011). Presence of a population bottleneck can be determined using a coalescence based method implemented in BOTTLENECK v.1.2.02 (Luikart & Cornuet 1998). Spatial

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genetic structuring will be examined by using STRUCTURE v. 2.3.4 (Pritchard et al 2000) with nuclear microsatellites and BAPS V2 (Corander et al 2004) with mtDNA. The sex of sampled dolphins will be identified by amplification of a fragment of the *sry* gene multiplexed with fragments of the ZFY/ZFX genes as positive control, and as described by Gilson et al. (1998).

Dolphin rescue, rehabilitation and disease monitoring: There were several incidences of dolphins getting isolated or injured. There is urgent need to develop appropriate protocol for keeping and nursing these dolphins till rehabilitation is done. Program will also develop protocol for transportation of dolphin. The Caracas will be assessed for disease as well as sampling will be done for potential disease causing organism known to affect dolphins.

CONSERVATION ACTION

Conservation awareness and participatory management: Awarenes amongst various stake holders and their involvement and conserving dolphin is most important. Dolphins are threatened by poaching, accidental bycatch and pollution of their habitat. We plan to develop "Dolphin Sanrakshaks" and "Dolphin Conservation Network". This will be done by engaging fishing community by employing fisherman as well as honorary positions along rivers. These individuals will be the nodal points in a community to create local network. The network will collect data about dolphins and other variables of interest in simple formats. For data collection, transmission and contact we will use mobile telephone network. We will also engage other stake holders (Industry- small and large) through the same model of "Conservation Network" (Shah et al 2010,Wakid 2012). We will engage media specifically radio to spread the message of dolphin conservation (Shah et al 2010). Schools and colleges in riverscape will be engaged in conservation program. The conservation awareness work will involve short films on dolphins, radio spots, Television programmes and traditional communication like theatre. We will prepare booklets and educational material for school and colleges to promote dolphin and river conservation issues.

Reduction in cause of mortality: One of the main reasons for poaching is dolphin oil which is largely used for fishing. There is urgent need to gather information about extent of this practice. Through afore mentioned awareness campaign we will try to convince people as well as provide alternative to replace dolphin oil by other substitute. There are lot of cases of accidental deaths of dolphins due to entanglement in fishing nets. We will experiment with the use of net aversion devices like pingers (sound device) and reflectors. The efficacy in terms of habituation and effectiveness will be tested in select areas. Once the efficacy and design will be standardized pingers and

reflectors will be promoted amongst fishermen and taken up with Fisheries department to ensure its use with Central and State Government's financial assistance. Dolphin conservation network will be used for information gathering for dolphin entanglement, poaching. The entanglement information will be relayed to nearest rescue centre and expert team for prompt action. Poaching information will be relayed to nearest forest chowki for action.

River habitat conservation: The major challenge in conserving river system is not only to save the integrity of riverine ecosystem but secure people's dependence. The issues are pollution from industry and human waste water disposal, agricultural intensification along river banks with increase in use of fertilizers and pesticides. These are complex issues and need policy interventions and awareness program. The effluents and pollutants from industry need to be managed by effluent treatment plant. This work is undertaken under Ganga cleaning action, the project will only collect relevant information affecting fauna and its impact across the river system to help develop appropriate mitigation strategy. Sand mining and its effect on river health need to be assessed, to develop comprehensive plan how to deal with this problem. Policy for water drawls and dams are important, to ensure ecological flow as well as provide connectivity between isolated populations.

Rescue centre: Temporary rescue centre at river fronts are needed in each state to rescue and rehabilitate dolphins which are injured during fishing activity or stranded during flood. Veterinary care unit in each state will develop a unit which will address any issue of veterinary emergency related to dolphin or other aquatic species. Plan and model will be developed to create temporary rescue units locally at time of need and appropriate transportation protocols. The dolphin conservation unit linked with mobile network will assist in providing information and assistance in rescue. This unit will also keep watch on disease and pollutant related incidents.

Capacity Building: The capacity building will be done for three major groups, scientist and researchers of WII and partner Institution, State Forest Department, Fisheries Department, Animal Husbandry Department and Fishermen.

1) Monitoring: State forest department personnel will be trained in scientific monitoring of dolphins and river system. The forest department personnel will be trained in two phases –
    i) The select Forest officer in-charge of Divison/Range having Ganga and Brahmaputra flowing through their Division will be trained and they in turn will train other staff members.

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ii) During survey the Forest Department teams will be trained in scientific monitoring. After completion of first survey and data analysis the process will be shared with each state. It is envisaged that from second survey onward the monitoring process will be done by states with assistance from WII and other partner agencies.

iii) Training will be done for fishermen network to monitor dolphins.

iv) School and college students will be trained in volunteer program for monitoring.

2) Scientist and Researchers of WII and Partner Institution will also get trained by National and International experts on various research protocols needed to monitor river health. Video conferencing and visits of National and International experts is visualized in this component.

3) Veterinarian from WII, State Forest Department, Animal husbandry units and Partner agencies will be trained in rescue, handling and data collection protocols related to Post mortem and sample collection. Rescue and Disease monitoring training in aquatic system will be done by National and International experts through video conferencing and expert visits.

4) Workshops for training and evaluation of project outcomes on annual basis as well as need based.

EXPECTED PROJECT OUTPUT

The action plan proposes following major outcomes;

- Standardized techniques for State Forest Department and Community based monitoring system for dolphins and their habitats.
- Recovery of dolphin populations due to reduction in mortality caused by accidental catch and poaching.
- Improved understanding of dolphin populations and their habitats.
- Awareness for conservation of dolphin and its habitat among various stakeholders.
- Develop a blue print for participatory management of dolphins and their habitats involving all concerned stakeholders including hydro-electric projects, irrigation, agriculture, oil sector and fisheries.
- Changes in fishery policy for control of invasive fish introduction and dolphin conservation.

- Identification of stretches of rivers crucial for dolphin and associated fauna conservation for community reserve. The community reserve will enhance the income of river dependent people through targeted investment by various Government departments.

- Strengthening the 'Clean Ganga' programme of the Government of India.

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Logframe for Dolphin Conservation Action Plan

Goal	Activity	Inputs	Assumption	Implimentation Time Frame	Output	Verifiable Indicators and Time	Risks
1) Increase in Abundance of Dolphins and associated fauna	1)Dolphin and associated species monitoring	Population estimation: Mark Recapture based estimates , Line transect , Under water detection using hydrophones	Infrastrectore and support of Forest Deptt	Initial 2 years to complete entire range after that survey in a season will be conducted by States	Population Estimates	Scientifically acceptable abundance estimate in 2 years time, after that annual estimate in crucial areas and biannual in entire stretch.	Law and order problem in certain river stretches Sustenance of activity on long term basis ie beyond project life
		Training of Forest Deptt staff	Acceptance and Willingness to impliment	Initial 2 years after this period only hand holding by associated agencies.	Timely and scientifically reliable results	Increased skill level in 2 years time	Loss of institutional interest and sustenance of activity
		Awareness and Training of Fishermen for Dolphin Monitoring	Fishermen will be willing and perceive benefit. Forest Deptt and Associated agencies like Fisheries Deptt. will participate	Will be actively involved after 1 or 2 years of network creation	Co-operation in conservation	Increasing trend in reporting of dolphin bycatch and poaching. Will take 2 to 3 years for full functionality	Unwillingness due to perception of threat to their livelihood. Lack of long term sustenance
	2)Decline in accidental catch of dolphins	Use of pingers and reflectors by fishermen	Willingness to use pingers and reflectors	After 2 years of experimentation, plan will be implemented in crucial dolphin areas	Decline in accidental catch and poaching incidence	Decline in reporting of accidental catch by fishermen network and monitoring sites	Lack of Co-operation and long term sustenance and replacement of equipments

Goal	Activity	Inputs	Assumption	Implimentation Time Frame	Output	Verifiable Indicators and Time	Risks
	3)Dolphin rescue and rehabilitation	Veterinary setup and temporary rescue centre at river fronts	State Forest Deptt. will provide infrastructure	Full functionality after 1 to 2 year of experimentation and learning	Decline in mortality of stranded and injured dolphins	Increase in survivorship of rescued dolphins	Lack of infrastructure and long term sustenance of rescue centre
	4)Use of alternative for dolphin oil	Create awareness and provide alternative for dolphin oil.	Will able to produce alternative which is good and acceptable	2-3 years for implementation	Decline in poaching reports	Increase in use of alternative. The alternative is as good as dolphin oil as cat fish lures.	Efficacy of alternate not as good as dolphin oil. Acceptability of alternative and its promotion by Forest and Fisheries Deptts.
	5) Habitat Mapping	Remote sensing data, Secondary data regarding flow, fish landings, development	Secondary data will be reliable and available over different time frame	2 years, Detail time series data in 3 - 4 years	Habitat map with critical conservation area and threat mapping	Land use map with information regarding riverscape quality and conservation value	Lack of good quality time series data from different agencies working in this area
	6) Genetic study	Samples across its range and lab analysis	Large sample size will be available	3-4 years	Level of genetic diversity and spatial nature of population will help in taking appropriate mitigation measures	Information on genetic diversity and level of isolation among different river stretches	Low sample size
	7) Fish Abundance	Sampling of fish at different locations. Fish landing site statistics.	Fish landing site information from historical time will be available.	2-3 years	Fish abundance index	Data about fish productivity from different reliable sources	low sample size and lack of historical data

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Goal	Activity	Inputs	Assumption	Implimentation Time Frame	Output	Verifiable Indicators and Time	Risks
2) Improvement of riverine habitat	2) Monitoring of habitat quality	Collect data for deleterious anthropogenic activity, fertilizers, pollutant load, water quality	The Ganga action plan will improve the riverine habitat quality and information generated through this project will be used in targeted action	1-2 years for water quality monitoring	Habitat quality indicators	Positive change in water quality parameters	Delay or failure of large scale implementation of Ganga cleaning program.
3) Protection of riverine habitat	1) Creation of Community and Conservation Reserves	Research inputs will identify important areas for dolphin and associated fauna. Government schemes to improve livelihood options	Local people, Fisheries Deptt and Forest Deptt will be willing to having participatory management	3-5 years	Creation of Community and Conservation Reserves	Creation of Community and Conservation Reserves	Lack of trust among local people about Forest Deptt. Largely from belief that they will be debarred from using the area
	2) Sensitization of Judiciary and associated Deptts	Workshop highlighting the status	Judiciary will be sympathetic to plight of riverine system and dolphin in particular	Workshop after 3 years	Sensitization of Judiciary and associated Deptts	None in given time frame	None
	3) Review existing Fisheries Act and Policy	Review by experts and stakeholders the existing rules and policies in fishery sector	The existing rules and policies can be amended on the basis of credible data	3-5 years	Draft Law and Policy changes	Workshop with stake holders and legislators with critical overview and positive outcome	Different Government Deptts will not be amenable to suggestions

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Budget

Heads	Particulars	Year 1	Year 2	Year 3	Year 4	Year 5	Total
Staff engagement	4 Project Scientists (2 ecologists, 1 sociologist, 1 veterinarian)	2,688,000	2956800	3252480	3577728	3935501	16,410,509
	2 Project Associates (2 IT & Communication)	542,400	1084800	1193280	1312608	1443869	5,576,957
	10 Project Fellows (6 ecologists, 2 sociologists, 1 remote sensing, 1 genetics)	2,304,000	3840000	4224000	4646400	5111040	20,125,440
	4 Project Assistant Grade 1 (2 ecologists/IT, 1 sociologist, 1 veterinary assistants)	0	729600	802560	882816	971098	3,386,074
	2 Project Assistant Grade 2 (1 ecologist/IT & 1 veterinary assistant)	480,000	528000	580800	638880	702768	2,930,448
	10 Field Assistant Grade 1 & interns	900,000	990000	1089000	1197900	1317690	5,494,590
	Project Management Unit at WII (part cost)	949,056	996509	1046334	1098651	1153583	5,244,133
	Total staff engagement costs	7,863,456	11,125,709	12,188,454	13,354,903	14,635,549	59,168,151
Research	Computers and communication equipments	3,700,000	500,000	500,000	300,000	200,000	5,200,000
	Software purchase, development and technical services	2,800,000	1,000,000	1,000,000	500,000	500,000	5,800,000
	Research & genetics lab (equipment part cost & sample analysis charges, RS-GIS lab & technical services)	5,200,000	1,000,000	1,000,000	500,000	500,000	8,200,000
	Dolphin, associated fauna & habitat monitoring equipment (Hydrophones, Sonar, Water quality sampling unit, GPS, Binoculars, Spotting scopes, Field microscopes, Pingers, fish finders, Unmanned aerial and underwater vehicles etc.), acessories (battery, stationary etc.) and chemicals	3,700,000	500,000	500,000	500,000	500,000	5,700,000
	River Survey (boat & vehicle hiring charges)	5,720,000	10,080,000	9,280,000	9,280,000	9,280,000	43,640,000
	Payment to additional field survey staff	576,000	576,000	576,000	576,000	576,000	2,880,000
	Travel and daily allowances	1,300,000	1,300,000	1,300,000	1,300,000	1,300,000	6,500,000
	Field station and office rental & maintenance charges	500,000	500,000	500,000	500,000	500,000	2,500,000
	Total research costs	23,496,000	15,456,000	14,656,000	13,456,000	13,356,000	80,420,000
Capacity building & awareness	Creation of Dolphin Saarakshak Network for incentive based conservation (payment to network members for survey & communication, use of pingers & reflectors, dolphin oil alternatives)	4,800,000	9,600,000	9,300,000	9,300,000	8,500,000	41,500,000
	Publicity materials (movie, radio spots, posters, handouts, theater groups, material for educational institutions, media collaborations & stakeholder meetings)	1,000,000	1,000,000	500,000	500,000	500,000	3,500,000
	Workshop and training of forest staff, researchers & other stakeholders	1,000,000	1,000,000	1,000,000	1,000,000	500,000	4,500,000
	Rescue and verinary facility (infrastructure, equipment, labour, transport, medicines & equipment/infrastructure maintenance)	1,000,000	1,000,000	1,000,000	1,000,000	1,000,000	5,000,000
	Documentation, publication & communication of results	100,000	200,000	200,000	200,000	300,000	1,000,000
	Total capacity-building & awareness costs	7,900,000	12,800,000	12,000,000	12,000,000	10,800,000	55,500,000
	Miscellaneous (contingency, unforeseen expenses & institutional requirements)	6,740,544	6,618,291	7,155,546	7,189,017	7,208,451	34,911,849
	Total cost	46,000,000	46,000,000	46,000,000	46,000,000	46,000,000	230,000,000

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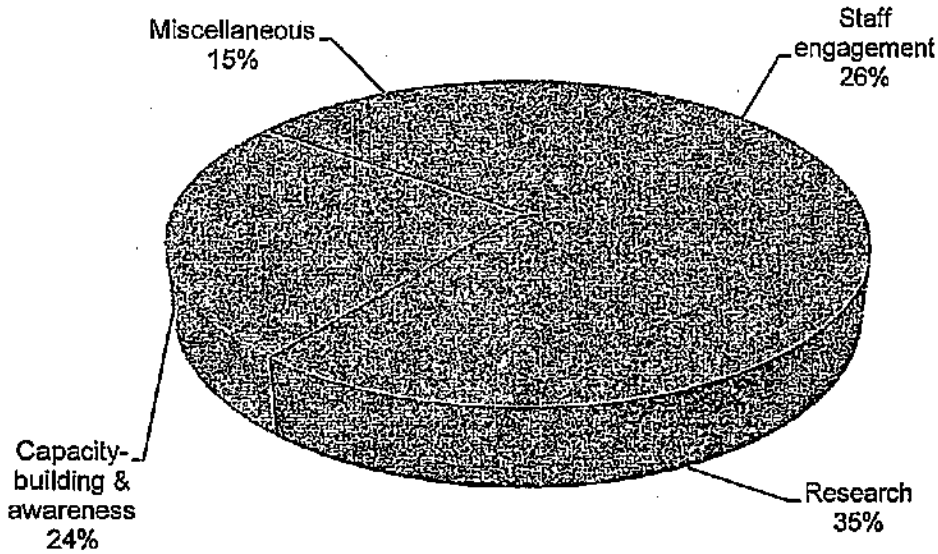
SUMMARY OF BUDGET

Head	Year 1	Year 2	Year 3	Year 4	Year 5	Total
Staff engagement	7,863,456	11,125,709	12,188,454	13,354,983	14,635,549	59,168,151
Research	23,496,000	15,456,000	14,656,000	13,456,000	13,356,000	80,420,000
Capacity-building & awareness	7,900,000	12,800,000	12,000,000	12,000,000	10,800,000	55,500,000
Miscellaneous	6,740,544	6,618,291	7,155,546	7,189,017	7,208,451	34,911,849
Total costs	46,000,000	46,000,000	46,000,000	46,000,000	46,000,000	230,000,000

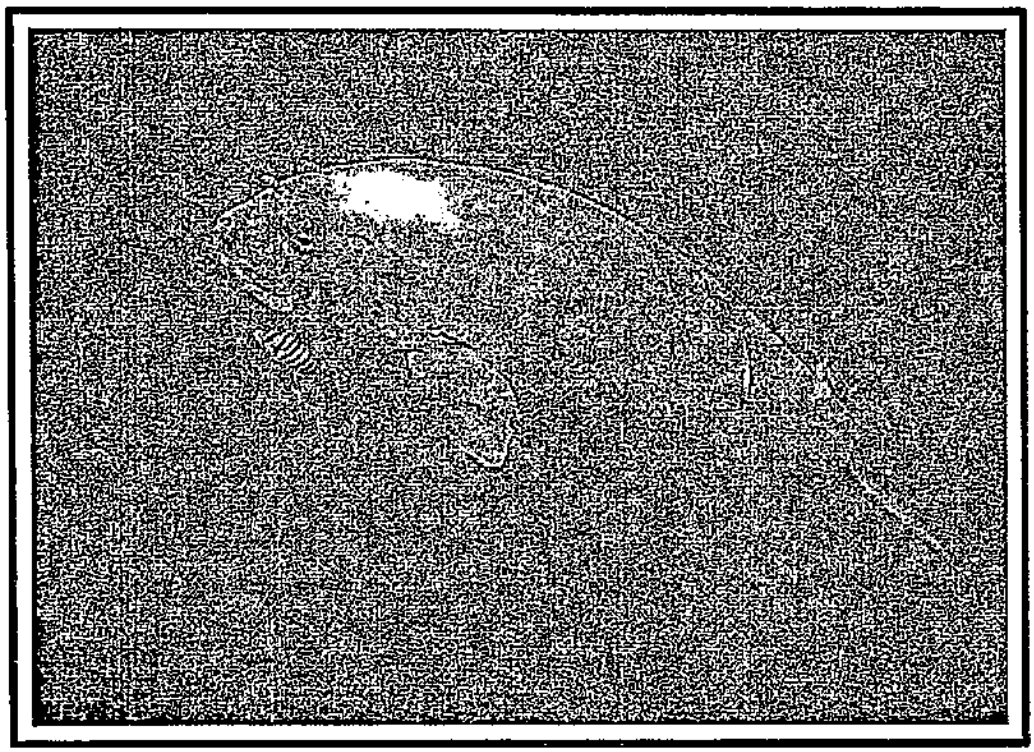
PIE CHART SHOWING BUDGET ALLOCATION FOR VARIOUS ACTIVITIES



Annexure-III

PROJECT TITLE

Recovery of Dugongs and Their Habitats in India: An Integrated Participatory Approach



Implementing agencies:

1. Wildlife Institute of India
2. State Forest Departments –Gujarat, Tamil Nadu, Andaman & Nicobar Islands
3. Indian Navy and the Indian Coast Guard

Collaborating agencies:

1. National Centre for Sustainable Coastal Management (NCSCM)
2. Indian Institute of Science, Education and Research – Kolkata (IISER-K)
3. Central Marine Fisheries Research Institute (CMFRI)
4. GEER Foundation, Gujarat
5. Centre for Marine Living Resources and Ecology (CMLRE)
6. International Collective in Support of Fishworkers (ICSF)
7. Bay of Bengal Program (BOBP)
8. Local NGOs

Funding Agency:CAMPA, Ministry of Environment, Forests and Climate Change

Budget: Rs. 23.58 Crore (Annexure-I& II)

Timeline: September 2015 – March 2020

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1. Project Background

Dugong (*Dugong dugon)* also called as 'Sea Cow' is one of the four surviving species in the order Sirenia and the only existing species of herbivorous mammal that lives exclusively in the sea (Heinsohn, 1972). Dugongs are naturally found in calm sheltered, nutrient-rich water, generally in bays, shallow island and reef areas which are protected from strong winds and heavy seas (Heinsohn et al.,1977) and which coincide with extensive seagrass beds (Marsh et al., 2002) and such seagrass habitats are still available in Gulf of Mannar, Palk Bay, Gulf of Kutch and Andaman and Nicobar islands in India (Kannan et al., 1999). However, dugongs are not confined to only inshore waters and have been sighted near reefs up to 80 km offshore in waters up to 37 m deep (Ripple, 1999). The population of dugongs in India is expected to be less than 250 individuals that too in highly fragmented conditions. Several reasons have been attributed to their population decline, some of which include sea grass habitat loss and degradation, gill netting, disease, chemical pollutants, indigenous use and hunting.

The National Board for Wildlife under the Chairmanship of the Hon'ble Prime Minister of India constituted two Sub-Committees comprising conservation experts for recovery of threatened terrestrial and aquatic species in India. These Committees have developed *Guidelines for Threatened Species Recovery Plan* and chosen a threatened aquatic marine species,Dugong, for preparation of recovery plans in the first phase. In this context, WII has herewith proposed to initiate the implementation of threatened aquatic species recovery programs for dugongs in partnerships with various stakeholders including the State/UTs Forests Departments under the auspicious of CAMPA.

Further, in order to conserve and manage the Dugongs at global level, the 7th meeting of the Conference of Parties to the Convention on Migratory Species (CMS) had passed a resolution and urged all Dugong range countries to cooperate among themselves to develop and adopt a 'Memorandum of Understanding' and an Action Plan for the Conservation and Management of Dugongs throughout the species range. In this connection, the Government of India has also signed this Memorandum of Understanding in April 2008 to strengthen the ongoing conservation programme of dugongs and their habitats in the Indian water with the support of international community.In this context, the Ministry of Environment, Forests and Climate Change (MoEFCC)of the Government of India constituted a 'Task Force for Conservation of Dugongs' to look into the entire gamut of issues related to conservation of dugongs and implementation of the 'UNEP/CMS Dugong MoU' in India. This task force will also facilitate for a leading role in the South Asia Sub-region with respect to dugong conservation. The Task Force had prepared the 'National Action Plan for Dugong Conservation in India'. This project supported by the MoEFCC under the auspicious of CAMPA is to initiate the implementation of the 'National Action Plan for Dugong Conservation in India' jointly with various stakeholders especially the State Forest Departments and other line agencies and the local communities.This five-year project is to initiate the conservation actions identified in the 'National Action Plan of Dugong in India' with expectation that the populations and habitats of dugong in India would recover within two decades.

1.1 Status of Global distribution of Dugong and their habitats

Dugongs are classified on the global Red List of IUCN as 'Vulnerable to extinction' (Marsh, 2008) and are included in Appendix I of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES, 2015). Dugongs only occur in tropical and sub-tropical waters of the Indo-Pacific region. Their range is extensive, spanning 37 countries and territories from East Africa to Vanuatu (Marsh et al., 2002). Approximately 85,000 of the world's dugongs are found in the inshore waters of northern Australia (Marsh & Lefebvre, 1994) which is likely to be atleast three-quarters of the global population, possibly even more (Marsh et al., 2002). The second-largest dugong population occurs in the Arabian Gulf where the population was estimated in 1987 at 7,310 dugongs (Preen, 1989; Preen et al., 1989). Elsewhere, populations are small and fragmented and in some areas, such as Mauritius, the Maldives and parts of Cambodia and Laos, dugongs may already have become extinct (Marsh et al., 2002).

1.2 Status of Regional distribution of Dugong and their habitats

Historically, the dugong distribution in India was reported as abundant but limited to Andaman and Nicobar Islands, Gulf of Mannar, Palk Bay, Gulf of Kutch, and Lakshadweep Islands (Annandale, 1905; James, 1974; Jones 1967, 1981; LalMohan, 1963; Nair *et al.*, 1975; Silas, 1961; Marsh et al., 2002). The most favored dugong habitats were the Gulf of Mannar, Interview Island and several inlets and bays around the Little Nicobar and Great Nicobar. About 250 dugongs were illegally caught and butchered at the villages of Kilakarei and Peripattinum alone between April 1983 and August 1984 (Silas and Fernando, 1985). This information clearly shows that once the Gulf of Mannar had a good population of dugong but due to illegal take of this species let the population under threat. Marsh (1989) concluded that Palk Strait and the Gulf of Mannar should be important areas for dugongs in India. The status of dugongs in this region is unknown, suspected to be almost completely depleted (Marsh et al., 2002).

There were sporadic records of dugongs on the west coast of peninsular India (Frazier &Mundkur, 1990), however, the only known dugong population remaining in western India is in the Gulf of Kutch (Lal Mohan, 1963; Frazier &Mundkur, 1990). Due to intensive fishing, pollution and various developmental activities, the dugong population in the Gulf of Kutch is on the verge of extinction (Singh, 2003). Dugong population off-coast of Lakshadweep Islands also seems to be extinct as there are no recent sightings of this species in this region.

Dugongs were common in Andaman & Nicobar Islands during the British era but steeply declined later due to poaching and habitat destruction. Dugongs were reported in Ritchie's Archipelago and Dugong Creek in Little Andaman are/were well-known areas for dugong in Andamans. Dugongs are not found in Dugong Creek at present. Moreover, large populations of Andaman & Nicobar islands are no longer seen, and numbers are believed to have been declining since the 1950s (Das, 1996).

Dugongs continue to occur in Gulf of Mannar and Palk Bay along the east coast and in Gulf of Kutch along the west coast of India. Dugongs also occur in Andaman and Nicobar islands. Results of a national level interview-based survey conducted by the MoEFCC, Government of India with help of GEER Foundation, Gujarat on dugong population and also observations made by the Central Marine Fisheries Research Institute and various other organizations in India have revealed that the dugong

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populations all over India are at the verge of extinction. At present, it seems that the largest populations of dugong in India are in Gulf of Mannar and Palk Bay region followed by Andaman and Nicobar islands, although the population size is presumed to be very small (Sivakumar, 2006; Choudhury and Sivakumar, 2008). Dugong population in Gulf of Kutch is already critically endangered (Singh, 2003). Tsunami of 2004 damaged much of the dugong habitats in the Nicobar regions, further threatening the dugong population here (Sivakumar, 2006). However, quantitative data on the status of the population of dugong in India is not available.

In 2009, the population of dugong in India was estimated between 131 and 254 individuals using an interview based survey conducted by the GEER Foundation. Of these, about 77 to 158 individuals were suspected to be occurring in the Gulf of Mannar, 44 to 81 individuals in the Andaman and Nicobar Islands and 10 to 15 dugongs were estimated in the Gulf of Kutch (Pandey et al., 2010).

Region-specific threats to the dugong and its habitat were recently identified by the Wildlife Institute of India (Sivakumar and Nair, 2013). Fishing is a major threat to dugong in Gulf of Mannar, Palk Bay and Gulf of Kutch, poaching/hunting is prevalent in Andaman and Nicobars, and pollution seems to be major threat to dugongs in Gulf of Kutch (Sivakumar and Nair, 2013). Occupancy models were built to identify critical dugong habitats using dugong sighting data from the past five years (2008 to 2012). The range of variables that influenced occupancy and detection were also assessed. Dugong occupancy was greatest in the Gulf of Mannar and Palk Bay, followed by the Andaman and Nicobar Islands, and lowest in the Gulf of Kutch. At present, the overall occupancy of the dugong in Indian waters is estimated to be 11% of the historical distribution (the 1950s) area. Only 21% of the area sampled in Tamil Nadu was found to be occupied by dugongs. The corresponding proportion was 12% in the Andaman and Nicobar Islands and 1% in the Gulf of Kutch. Status of dugong in some of the inaccessible areas such as West Coast of South and Middle Andaman were not known as these areas are Tribal Reserve. Overall, the dugong distribution range has significantly decreased by about 85% in the distribution range of the dugong in India (Sivakumar and Nair, 2013). Similarly, there is an estimated 60% decline in dugong occupancy in last 20 years in Andaman and Nicobar Islands (Dsouza et al., 2013).

1.3 Major Threats

Several reasons have been attributed to the dugong population decline, some of which include seagrass habitat loss and degradation, gill netting, disease, chemical pollutants, indigenous use and hunting, etc. Dugongs are vulnerable to anthropogenic pressures as they are solely dependent on seagrasses in coastal areas which now have been seriously damaged by fishing, trawling and dredging, etc.(Marsh *et al.*, 2002, Nair *et al.*, 1975, Das and Dey, 1999). Dugongs have also been hunted for their meat, oil, hides, bones and teeth. However, hunting has been totally banned in several countries including India.

Feeding grounds of dugong i.e. sea grass beds are highly degraded due to changes in the fishing methodology. Traditionally, fishermen used non-mechanized boats for fishing in the shallow waters; however, due to modernization of fishing technology, traditional crafts were gradually replaced by mechanized crafts like bottom trawlers that cause severe damage to seagrass beds. Moreover, water pollution and siltation have also hampered this unique habitat of the dugong. Although dugong is getting highest protection by law but still there have been reports of poaching done by fishermen for

dugong meat. In Ritchie's Archipelago, growing tourism activities especially high-speed vessels and speedboats have become a major threat for local Dugong population.

1.4 Current Status of Regional Conservation

The Dugongs are protected under the Schedule-I of the Wildlife (Protection) Act 1972, which provides the maximum protection to a species in the Indian Territory and also prevent any trade on this species. The Dugong population across the world is also declared as Vulnerable by IUCN and listed in Appendix-I of CITES, which prevent international trade on this species. Being a signatory, the Government of India strictly adheres to the CITES rules and regulations to prevent trade on protected endangered species including dugong.Moreover,large portions of dugong habitat in India have been included in the existing Wildlife Protected Areas Network, for example, Gulf of Mannar Marine National Park, Gulf of Kutch Marine National Park, M.G. Marine National Park etc. A study carried out by Ilangakoon et al (2008) during 2004 had also revealed that the incidental catch of dugong by fishermen is significantly lower in Indian part of Gulf of Mannar than Sri Lanka and it was due to awareness and protection provided by joint efforts of Government of India and Tamil Nadu Forest Department. Government of India has also signed the MoUon the Conservation and Management of Dugongs and their habitats throughout their range in April 2008 to strengthen the ongoing protection and management of dugongs and their habitats in the Indian water with the support of international community. Additionally Government of India along with State Forest Departments has initiated awareness programme among fishermen communities to minimise the incidental capture of this species and also to protect their sea grass habitats (Choudhury and Sivakumar, 2008). Further, the National Board for Wildlife under the Chairmanship of the Hon'ble Prime Minister constituted two Sub-Committees comprising conservation experts for recovery of threatened Terrestrial and Aquatic species in India. These Committees have already developed Guidelines for Threatened Species Recovery Plan and also selected certain threatened species on a priority basis that include dugong.

2. GOALS AND OBJECTIVES

The broad goals and objectives of this project are as follows:

Goal 1: Species conservation and management

Assess Dugong population status through advanced census techniques and determine its abundance and distribution, identifycritical habitats, classify threats and develop site-specific monitoring plan to reduce hunting and incidental entanglements.

Goal 2: Habitat conservation and management

Characterize the critical Dugong habitats, reduce direct and indirect threats, control modifications in and around the habitat and improve habitat quality through management interventions and participatory approaches.

Goal 3: Creating awareness about Dugong and its habitats

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Raise awareness on the species and encourage the participation of the local communities; include other stakeholders like fisheries department and religious heads in conservation efforts; enhance Dugong conservation program by spreading awareness on a national scale.

Goal 4: Capacity-building of the State Forest Department & local communities
Enhance the capacity of the State Forest Department staff and develop/implement smart patrolling tools to improve protection enforcement; train forest staff and local communities in underwater surveys for long-term habitat monitoring.

3. Scope of work

3.1 Species conservation and management

Wildlife Institute of India in collaboration with State Forest Departments, other line departments, Indian Coast Guard, Indian Navy, NGOs and local communities would carry out detailed population and habitat surveys to address the gaps in the knowledge of Dugong ecology in its range states. This program will involve State Forest departments and local communities of three state/UTs viz. Gujarat, Tamil Nadu and Andaman & Nicobar Islands. Existing Dugong habitatshave already been identified by conducting extensive field and questionnaire surveys by Wildlife Institute of India. Intensive aerial surveysusing aircrafts and drones would be conducted jointly with the Indian Coast Guard and State/UTs Forests Departmentsto generate baseline information on the occupancy and population statusof Dugongs in all three regions in India. Further,drone-based continuous monitoring will be conducted to monitor anddetect changes in populations. Information on dugong behaviour, habitat requirement and associations with other fauna and flora will be simultaneously collected for successful restoration of dugongs and their habitat.

Nevertheless, low population size, fragmented habitats in marine habitats and high mobility makes it challenging to gather information on dugong biology. To facilitate population recovery and assess long-term population viability, we also need to study population genetics of dugong populations across their habitats in the Indian seas. This genetic viability assessment would help us to intervene in the genetic diversity of the population by mixing of stocks through translocation if required. Molecular techniques would be used to investigate the populationgenetic structure of dugongs based on both mitochondrial and nuclear markers.

Further, advanced monitoring methods like Unmanned Aerial Vehicles (UAVs) or drones will be used in monitoring native populations of dugongs. Dugong field camps will be established at all study sites in Gulf of Kutch, Gulf of Mannar, Palk Bay and Andaman & Nicobar Islands to support drone-based monitoring. Acoustic surveys will also be attempted for identified dugong populations to understand social behaviour of the species.The vocalisation patterns differ for the calving, non-calving herds and solitary individuals (Ichikawa et al., 2012) and acoustics can reveal their distribution patterns to assist space-based management of their populations.

Traditional knowledge of fishermen in the Palk Bay reveals that the population here seems to be migrating between the coastal waters of India and Sri Lanka. Therefore, this project proposes to use satellite tracking of Dugongs for mapping their movements and fine scale habitat use and support conservation planning of its habitats. Ten Dugongs will be tagged and monitored remotely at a later stage of the project after the initial baseline surveys. Satellite tracking will provide vital information on seasonal movement patterns, critical habitats, interaction with fishing vessels and connectivity between seascapes. The crucial information generated will be used to identify and delineate *restrictive-use zonesor open sea enclosures*where a compensatory mechanism can be initiated.

The main causes of mortalities of Dugong individuals will be assessed by interviewing the local communities, forest department staff; other stakeholders; and with direct field based observations. Incidental fishery entanglements are a major reason behind dugong mortality (D'Souza et al 2013; Marsh et al 2002) and conservation measures will be taken to regulate harmful practices like gillnetting in dugong habitats. An index of the threats will be developed to reduce the mortalities at the identified habitats. A compensatory scheme will be initiated at small scale around the prime dugong habitats identified by the first year surveys where direct threats like fishing net entanglements will be minimized and fishing activity regulated. A compensation model will be developed in consultation with forest staff and dependent communities and evaluated based on indicators such as reduced mortalities/boat strikes, increased sightings etc. A larger scale compensatory mechanism can thus be implemented by the State Forest Departments in dugong range areas with funds available from state CAMPA to involve more stakeholders at later stages.

A Marine Mammal Rescue and Rehabilitation Facility (M2R2F)would be developed on trial basis in Palk Bay and Gulf of Mannar region, where many strandings of dugongs have been reported in the recent past. This unique facility would be developed by providing additional capacity to existing veterinarians and managers in the region to handle the rescued dugongs as well as other marine mammals. The facility would be simultaneously developed in selected sites in Gujarat and Andaman & Nicobar Islands as well identified thorough applied research in the first three years. This facility would also look into certain aspects of marine mammals diseases in the region. The support of the Civil Construction Unit (CCU) of MoEFCC would be taken for construction of M2R2F at the project sites with the help of the State Forest Department.

3.2Habitat conservation and management

The seagrass beds which are the foraging grounds of Dugong will be intensively studied with boat based surveys in the previously identified sites (D'Souza et al 2013; Sivakumar& Nair 2013). Seagrass meadow characteristics including depth, wave exposure, species composition, shoot density and patchiness will be measured by undertaking underwater assessments (Lal et al 2010). Habitat requirements of dugong and its associated fauna would be studied, so that, a better habitat management as well as habitat restoration programme would be taken up during this project period.

Ecological Quality Status (EcoQS) of seagrass habitats frequented by dugongs will be assessed using seagrass-associated benthic organisms (as epifauna) or in underlying sediment (infauna) where seagrass grow, as a tool for such evaluation. The EcoQS map will help us to ascertain sectors of

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seagrass bed that need immediate protection and ultimately help in conservation of dugong population by effective habitat management. Additionally, the EcoQS maps can help us to better evaluate the ecosystem services rendered by seagrass habitats and its economic value from monetary perspective.

Water quality parameters will be measured seasonally to assess the impact of pollution, turbidity, and silt deposition etc. on the health of the seagrass meadows. Urgent management interventions will be suggested based on the assessment to reduce any negative impact thereof.

Threats to seagrass ecosystems will be monitored with intensive boat surveys at all the sites. Harmful fishing practice like bottom trawling at critical dugong habitats will be regulated especially during the breeding seasons and at seagrass habitats. Possibility of seagrass transplantation (Katwijk et al 2009) would be studied during this project period.

Critical Dugong Habitats that are outside the Protected Areas would be monitored intensively. A small portion of seagrass beds approximately 12 sq.km area would be marked in the Palk Bay region as a *Control HabitatEnclosure* free from fishing and other anthropogenic activities. Changes in the habitats and its fauna would be monitored inside this enclosure to understand the fishing pressure on seagrass habitats. Further, economics of ecological services of this enclosure would also be studied to compensate the fishermen who incur loss due to this enclosure monitoring.

Moreover, the Governments of State/UTs of Dugong range would be encouraged to bring the dugong habitats that are outside PAs under the management regime exclusively governed by the local communities especially the fishermen communities. Management of these identified areas would be facilitated by the State/UTs Fisheries and Forest Departments with support of State/UTs CAMPA Funds.

3.3 Creating awareness about Dugong and its habitats

Extensive campaigns for spreading awareness on dugong conservation will be conducted in and around the project sites to involve fishers, forest staff, school students etc. Wildlife Institute of India in association with related organizations would develop nature education and awareness materials for general public, school and college students, fishermen communities etc. Local stakeholders will be identified through these campaigns and information in the form of reading material; posters etc. will be distributed to generate interest and awareness. Fishery societies at all the sites will be targeted with these campaigns and enthusiastic volunteers will be identified and trained for reporting dugong sightings. An incentive-based *Dugong Volunteer Team* will be created where all the direct sightings, strandings, entanglements and mortalities can be reported in real time using mobile phones equipped with cameras. Religious heads of different communities at the project sites will be involved in the project to reach out to the masses about the need to conserve dugongs.

A documentary film on dugong titled 'Sea Angel' aimed to educate people towards ecology, behaviour, ecological services of dugongs and their habitat etc would be produced during the project.

Further, the progress of this species recovery project would also be documented for spreading knowledge about the conservation actions.

3.4 Capacity-building of forest staff and local communities

A capacity needs assessment would be carried out for the better management of dugongs and their habitat in India. Based on the capacity need assessment, special capacity building programs would be initiated for frontline staff and managers from the dugong range states.

Participantsfrom the three states of Gujarat, Tamil Nadu and Andaman & Nicobar Islands will be trained at WII for Post Graduate Diploma in Advanced Wildlife Management (9 months) and Certificate Course in Wildlife Management (3 months). Frontline forest staff of the three states will also be involved in all the field- based sampling and research to train them for long-term species monitoring. Additionally, a 15 - day special training on SCUBA diving, snorkelling and underwater biodiversity monitoring would be carried out for the frontline staff of the State Forest Department, members of the Dugong Volunteer Teams and researchers in the dugong habitats.

A three-day on-site training will be provided to concerned stakeholders for providing a holistic approach towards Dugong conservation and management. The stakeholders involved will be representatives from frontline forest staff, local communities, local administration, students, researchers and private players.

An integrated management plan for dugong conservation will be developed at five sites in consultation with state forest department and local communities to conserve prime dugong inhabited areas. The project proposes to initially target Gulf of Kutch Marine National Park, Gulf of Mannar Marine National Park & Palk bay; and Rani Jhansi National Park & Mahatma Gandhi Marine National Park (A & N islands).

Additional facilities required for management of dugongs and their habitats inside and outside PAs would be identified by the Wildlife Institute of India and established by the concerned State/UTs with the State CAMPA Fund. Facilities would largely be required for protection and monitoring of dugongs, underwater monitoring of seagrass beds and associated fauna, monitoring of marine pollution etc.

4. Approaches/ Methods

Wildlife Institute of India in collaboration with its partner institutions/NGOs and State Forest Departments will initiate work as discussed in the section 3 in dugong range areas. The following activities will be taken up by WII to achieve the goals set up for Dugong recovery:

4.1Participatory assessment of dugong populationsand theirhabitat

Populations of dugong would be assessed using aerial surveys jointly with the Coast Guard and the Indian Navy. Aerial strip transects will be conducted for estimating the population density of

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Dugongs (Marsh & Sinclair 1989; Marsh *et al.* 1994) at the three project sites i.e. Gulf of Kutch, Gulf of Mannar Biosphere Reserve & Palk Bay and Andaman & Nicobar islands. The survey areas will be demarcated using satellite imagery on a GIS domain and survey points will be identified. A small fixed wing aircraft (privately hired or coast guard supported) will be flown at a ground speed of 100 km h^{-1} at an altitude of around 80 to 100 m above sea surface. Transect strip width will be kept upto 400 m (200 m on each side of the aircraft). The survey crew will include a team of two observers on each side of the aircraft, who will record observations separately on tape recorders. Dugong group size, number of calves and number at the surface will be recorded for each sighting along with GPS co-ordinates, altitude and time. Environmental parameters such ascloud cover, sea state, turbidity will be recorded every 15 min. The record of each flight will be audio-taped for post-survey checking. Apart from dugongs, sightings of other marine mammals and turtles will also be recorded during the aerial survey. The location of seagrass beds would also be recorded during the aerial surveys for subsequent ground-truthing using boat-based surveys (Marsh et al 2002).

Based on prime habitats of dugong identified through aerial surveys, intensive boat surveys will be carried out using straight line transects. Number of individuals sighted,sighting distance and sighting angles will be measured to estimate the density of dugongs in *Critical Dugong Habitats* (CDHs).

Extensive field data will be collected in the CDHs divided into grids mapped on a GIS domain before collecting the data. Sampling will be done using SCUBA diving/snorkelling during clear weather and low tide conditions. At each grid, vegetation plots will be established to assess the health of the seagrass beds. Data on species composition,shoot density, percent cover, blade/ leaf height, substrate, distribution etc. will be collected seasonally. Associated benthic fauna will also be quantified from these plots and data on species composition will be collated. Dugong feeding signs will be recorded as and when encountered. Along with the seagrass data other environmental and habitat variables like, depth, water temperature, nutrients, salinity, bed characters, human disturbance etc. will be recorded. In addition to the field data, existing information on sea grass data, maps from Forests Department and other agencies will be used for the base references.

All the field assessment and monitoring work would be carried out with active involvement of local communities and State Forests Departments so that the programme would be institutionalized and carried forward.

4.2Participatory monitoring of dugong populations and their habitats

UAVs or drones fitted with digital cameras will be employed to survey seagrass beds known to be frequented by dugong herds where a series of parallel line transects will be laid (Hodgson et al 2013). The effective transect width will be calculated on the basis of width of view available at each altitude (500-1000ft). The transects will be equally spaced and flown over regular intervals on monthly/fortnightly basis to obtain crucial data on movement, habitat-use and improved count of the identified dugong populations.

Satellite tracking of dugongs would be conducted for mapping their movement patterns and fine-scale habitat use. Up to ten adultdugongs (without calf) will be captured under standard circumstances and with appropriate methods (Lanyon et al. 2006; Sheppard et al. 2010) at the

selected project site (Gulf of Mannar or A & N islands).Argos PTT/ GPS satellite tags will be fitted on to the body using a harness (Sheppard et al 2010) and monitored by transmitting location information to remote computers.

Seasonal sampling will be undertaken in seagrass habitats which are frequented by dugong population based on NaGISA protocol (http://nagisa.cbm.usb.ve), in addition to seagrass sites which are yet to be foraged by dugongs. Epiphytic benthic fauna and sediment samples for benthic infauna analyses will be collected using hand held corers. At the time of sampling, environmental *in situ* parameters of surface water (pH, temperature, salinity, dissolved oxygen, secchi depth, depth, total alkalinity) along with measurement of environmental parameters of underlying sediments on which seagrass beds are found will be undertaken. Dissolved nutrients of surface water and sediments will be collected and analyzed in the laboratory using spectrophotometry as well as Inductively Coupled Plasma-Mass Spectrometry (ICP-MS). Benthic fauna will be enumerated, sorted and taxonomically identified using standard keys. Imaging of taxonomically intractable benthic faunal groups will be undertaken using Field Emission-Scanning Electron Microscopy (FE-SEM) as well as using high resolution Bright-field microscopy. The ECoQ analyses will be undertaken for seagrass habitats, mapped and vulnerable seagrass habitats will be identified based on analysis of generated benthic faunal datasets and identification of such seagrass habitats is important for long-term conservation of dugong population.

Along with ecological monitoring, we will also use molecular genetic approaches to assess population size, genetic diversity, population structure, gene flow and its' rate and direction and demographic patterns during this project. As no such work has been done in any Indian Marine mammal, we will develop most of the methods during the project tenure. A number of techniques have been described for sample collection from marine mammals (for example Lanyon et al. 2010), but initially sampling will be done from tagged individuals, and opportunistically collected from dead and stranded animals during fieldwork. In addition, we will also collect opportunistic dugong faecal samples as biological materials. Samples will be collected in sterile Eppendorf tubes and stored in absolute ethanol. The samples will be transferred to - 20°C freezer in the laboratory along with all associated location data. DNA from tissue samples will be extracted using Qiagen Tissue DNA extraction kit following manufacturers' protocol. We will then standardize both mitochondrial (mtDNA) and nuclear (microsatellite and sexing) markers for further genetic analyses. A number of genetic studies on dugongs (McDonald 2005; Broderick et al. 2007; Bushell 2013; Blair et al. 2013, Seddon et al 2014; Cope et al. 2015) will help us to find useful markers. Following selection and standardization of suitable markers we will amplify them from field-collected samples. PCR products will be purified using Exo-SAP mixture and then sequenced from both directions in an ABI sequencer. Amplified microsatellite products will be run along with suitable size standards for genotyping and alleles will be called using program GENEMARKER (Softgenetics Inc., USA). The mtDNA sequences will be aligned and assembled using MEGA ver 6 (Tamura et al. 2005). Summary statistics of genetic diversity data will be calculated with program DnaSP (Librado and Rozas, 2009) and ARLEQUIN (Excoffier et al. 2005). Spatial genetic structuring will be examined by using STRUCTURE v. 2.3.4 (Pritchard et al. 2000) with nuclear microsatellites and BAPS V2 (Corander et al. 2004) with mtDNA. To detect gene flow among different populations we will use multiple approaches with our genetic data. First, we will use program STRUCTURE 2.3.2 (Pritchard et al. 2000) to detect first-generation migrants in our sampled populations. We will use prior population

information in the USEPOPINFO option with run conditions described earlier. Further, we will use 'Migrant detection' function described in program GENECLASS 2.0 (Piry et al. 2004) to confirm the first generation migrants. This method allows detection of migrants even when the overall differentiation between populations is low. Finally, we will use Bayesian assignment approach implemented in program SCAT ver. 2.0 (Wasser et al. 2004, 2007; Mondol et al. 2014) to support our GENECLASS and STRUCTURE results. The advantage of this approach lies in its use of geographic location information from the reference samples, and resulting assignment of each unknown individual to a geographic location. We will initially conduct exploratory runs with multiple combinations of input parameters (burn-in, thinning and iterations) with the entire data to select the best parameter combinations, and finally use the best parameter combination for our genetic data to identify migrants (Mondol et al. 2014). To estimate the direction and rate of migration we will use coalescent program LAMARC (Kuhner 2006). Effective population size will be calculated using program LAMARC (Kuhner 2006). Estimation of population decline will be determined using both qualitative (BOTTLENECK; M-Ratio, LAMARC) as well as quantitative (msVAR) approaches.

Acoustic surveys have also been planned on a trial basis to understand social behaviour of dugong populations at the project sites. A towed stereo hydrophone array will be operated from the survey boats in dugong around the focal area at a towing speed of 10 km/h. Sufficient distance (500 -1000 m) will be kept between parallel cruise lines to cover a wider area of dugong distribution (Ichikawa et al 2009, 2012).

All the field monitoring work would be carried out with active involvement of local communities and State Forests Departments so that the programme would be institutionalized and carried forward.

4.3 Threat assessmentandmitigation

Threats to dugongs and their habitats will be quantified by a two-pronged approach of indirect and direct information gathering. Previously conducted questionnaire surveys (Sivakumar& Nair 2013) will be used as baseline for conducting extensive verbal interviews of local fishers, villagers, trawl operators, forest staff and other stakeholders. Information on dugong and seagrass distribution, abundance, traditional knowledge, beliefs, traditional/modern use, sighting reports, and estimates of mortalities will be generated to understand threat levels of various activities.

Identified CDHs in the study areas would be monitored for fishing/shipping activities. Number, type of boats, number of fishermen, demography of fishermen, type of fishing gear, time spent near the habitat, CPUE, cost of catch etc. would be recorded for all boats. These boat surveys would be supplemented with information gathered from interview surveys described above. These details would help to understand the resource use pattern and dependency level of fishermen community in the critical dugong habitat of Gulf of Kutch, Gulf of Mannar& Palk Bay and A & N islands.

Water samples will be collected monthly from select points within the CDHs to assess the pollution levels, turbidity and other parameters. Causative factors of pollution like presence of fishing

boats/trawlers, ships etc. will also be noted down for preparing management guidelines for the CDHs.

The data generated from interviews and direct boat based surveys would be used to identify areas of repeated conflicts and mortalities. A compensatory scheme will be initiated for fishermen who will be asked to reduce the usage of gill nets in and around the dugong habitats and also encouraged to release any individual caught in the fishing nets. Photographic evidence would be required to provide compensation on a case to case basisaround the prime dugong habitats. Compensation to verified release events or no-fishing practices will be provided on a smaller scale and a model would be developed to implement it on a larger scale. State Forest Departments would be encouraged to make use of this model with funds available from state CAMPA to reduce fishery related mortalities and will be assessed on a regular basis.

Immediate mitigation measures visualized at this stage are to provide incentives to fishermen who rescue and safely release back the incidentally captured dugong. Further, protection and patrolling capacities of the local management authorities who govern the dugong habitat would be strengthened by enhancing their communication facilities and enabling them with smart patrolling tools.

4.4 Capacity building and awareness

Augmenting Dugong conservation efforts of the forest department is necessary for recovery and long-term survival of the populations. Participants from the state forest department of Gujarat, Tamil Nadu and A & N islands will be trained at WII for diploma and certificate courses in wildlife management every year. A 15 -day special training will be organized for selected participants to train them in SCUBA diving, boat surveys and underwater biodiversity monitoring techniques. This training would also involve selected members from local communities and other stakeholders to train them in Dugong monitoring and mentor these as members of *Dugong Volunteer Teams*.

A three-day on-site training on Dugong conservation and management for select representatives of all the local stakeholders will be conducted at the project sites every year. These events would be supported by mobile campaigns to raise awareness on the species and threats to its existence over the coastal districts along the Dugong range habitats.

Infrastructure for a Marine Mammal Rescue and Rehabilitation Facility would be developed initially in Palk Bay and Gulf of Mannar region. The same facilities would be extended to Andaman & Nicobar and Gulf of Kutch subsequently. Marine mammal specific training will be provided to the existing veterinarians and forest managers in the region to handle the rescued dugongs as well as other marine mammals. Special training for handling marine mammals and facilitating their release into the sea would be sought with the help of funds from othersources (e.g. Corporate Social Responsibility funds).Civil Construction Unit of MoEFCC which has aMoU with WII would be brought in to expedite the construction work in consultation with Tamil Nadu Forest Department (subject to land availability and other requirements).

Major fishing villages at each project site will be targeted for awareness campaigns where reading material, posters etc. will be distributed. These campaigns will be conducted in consultation with the

fishing societies operating in these areas and also local stakeholders. The project aims to reach out to over 70 % of the working population in these areas through these campaigns. Five enthusiastic volunteers will be identified at each site and will be trained for reporting dugong sightings. An incentive-based *Dugong Volunteer Team* will be created where all the direct sightings, strandings, entanglements and mortalities can be reported in real time using mobile phones equipped with cameras. Religious heads of different communities at the project sites will be involved in the project to reach out to the masses about the need to conserve dugongs.

A documentary film (tentatively titled *Sea Angel*) has been planned on conservation needs of dugong populations at selected project site for creating awareness at a larger scale.

An integrated management plan for dugong conservation will be developed at five sites in consultation with state forest department and local communities to conserve prime dugong inhabited areas. The project proposes to initially target Gulf of Kutch Marine National Park, Gulf of Mannar Marine National Park & Palk bay; and Rani Jhansi National Park & Mahatma Gandhi Marine National Park (A & N islands).

5. Expected Project Outputs

The outcomes of this project will help in restoring the dugong populations and their habitat in India thorough a participatory approach. This project aims to produce replicable results which can be utilized to aid recovery of other threatened marine mammal species in India.

5.1 Species and habitat recovery

This project would be able to provide comprehensive information on the status, distribution and abundance of Dugong populationsin the states of Gujarat, Tamil Nadu and Andaman & Nicobar Islands at the end of five years. The critical Dugong habitats would be subsequently mapped and improved knowledge on their ecological status will be available for making informed management interventions. Vital information on seasonal movement patterns and population connectivity would be generated to aid long-term population monitoring at all the sites. The threats to the Dugong populations would be enumerated, assessed and mitigation actions would have been put in place to halt species decline and habitat degradation. The fishing resources of the Dugong habitats would show improvement and help enhance the livelihood of the local communities.

5.2 Enhanced management and capacity

The State Forest Department would be better prepared for managing Dugong populations and habitats with knowledge on essential monitoring techniques. The critical habitats will be well-monitored and there would be reduced reports of hunting and fishing net entanglements. The enhanced protection measures would be in place for the critical Dugong habitats and majority of the population will be protected. Infrastructure and trained personnel would be available for treatment of injured/stranded individuals. The local communities would be effectively involved to assist conservation efforts through various participatory approaches. Participatory management of dugongs and their habitats would have involved all concerned stakeholders including production sectors.

5.3 Increased awareness and regional cooperation

The project would be able to generate public interest on Dugongs and threats to their populations and habitats at a wider platform. The fishing communities, villagers, agriculturists, shipping industry, forest managers, and .local leaders would have been sensitized and involved in the Dugong conservation program in various roles. Communities would have a larger participation in the species recovery program while government institutions, NGOs, private sectors would support research, conservation and management efforts.

5.4 Long-term Conservation Model for Dugong

Based on the information generated with this project and enforcement of the mitigations measures, we expect to see a substantial recovery of Dugong and their habitats in the range states. However, as per the currently available information, population of Dugongs in Gujarat is threatened with extinction. The successes of this project might be utilized in strengthening the status of this species in India with advanced conservation measures like translocation of individuals. Genetic assessments of existing Dugong populations would be critical in determining the genetic lineages and differentiation levels. This information would be used in re-populating the areas which have lost genetically viable Dugong populations. The Dugong Recovery Plan would ensure that the populations in the current range states and associated habitats and species show a recovery over the next two decades.

6. Budget –Cost Justification& Summary – Annexure –I& II

7. Log frame for Dugong Conservation Action Plan(monitoring indicators)

Goal	Activity	Inputs	Assumption	Implementation Time Frame	Output	Verifiable Indicators and Time	Risks
1) Generating ecological information on Dugong and associated habitats	a) Dugong and associated species assessment and monitoring	Population estimation: Aerial Transects , Boat transect , Drone surveys, Under water detection using hydrophones	Availability of Aerial support, offshore monitoring tools & infrastructure and support of State Forest Dept.	Initial 2 years to cover all three states and later on boat-based surveys to detect changes	Population Estimates	Scientifically acceptable abundance estimates Annual estimates in critical habitats Improvement in Demographic trends 2 Years	Conflict with fishermen may delay the estimation process Possible delay in getting the collaboration of Indian Coast Guard/Navy for aerial surveys Hindrance in continuing monitoring on long term basis i.e. beyond project life
		Dugong and associated species spatio-temporal distribution	Availability of Aerial support, offshore monitoring tools & infrastructure and support of State Forest Dept.	Initial 2 years to cover all three states and later on boat-based surveys to detect changes	Distribution and Habitat use of Dugong and associated species	Scientifically acceptable spatio-temporal distribution data in 2 years' time Seasonal distribution	Conflict with fishermen & shipping industries Delays due to permission issues in international

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Goal	Activity	Inputs	Assumption	Implementation Time Frame	Output	Verifiable Indicators and Time	Risks
						data in critical habitats Factors affecting habitat-use information 2 Years	border/ defence controlled areas
	b) Critical Dugong Habitat mapping & monitoring	Seagrass habitat mapping Associated benthic fauna mapping Monitoring for detecting changes	Availability of offshore monitoring tools, trained manpower, infrastructure and support of State Forest Dept.	Initial 2 years to cover all three states and later on underwater monitoring to detect changes	Seagrass extent and composition Habitat quality Identification of indicator species	Ground-truth data on seagrass habitat extent, quality and composition in 2 years' time Information on deleterious factors affecting habitat quality 2 Years	Conflict with fishermen & shipping industries Delays due to lack of specialised manpower and permission issues in international border/ defence controlled areas
	c) Genetic assessment of Dugong populations	Samples across its range and laboratory analysis	Sufficient sample size will be available	3-4 years	Level of genetic diversity and spatial nature of population will help in taking appropriate mitigation measures	Genetic diversity and level of isolation among spatially isolated populations 3-4 years	Lack of enough samples
2) To enhance capacity of state forest department, local communities & other stakeholders in Dugong conservation	a) Awareness and Training of State Forest Department, local communities and other stakeholders for Dugong Monitoring	Specialised training of Forest Dept. staff Enhancing awareness by inclusive activities	Acceptance and Willingness to implement Availability of specialised tools & infrastructure	Five years to systematically include representative forest staff	Trained forest staff in underwater & offshore monitoring Increased know-how of effective tools and methods	Increased skill level Effective monitoring Reduced threats & mortalities 4-5 years	Loss of Institutional interest and sustenance of activity
		Specialised training of local community representatives Enhancing awareness by inclusive activities	Fishermen will be willing and perceive benefits Forest Dept. and Associated agencies will sustain it on long term basis	Sustained involvement during the entire project duration Will take 2 to 3 years for full functionality	Co-operation in conservation & monitoring Increased awareness	Increased reporting of Dugong entanglement, mortalities and strandings Decline in conflict incidences with fishermen Reduced use of critical habitats	Unwillingness due to perception of threat to their livelihood. Lack of long term sustenance

Goal	Activity	Inputs	Assumption	Implementation Time Frame	Output	Verifiable Indicators and Time	Risks
						Improved habitat quality & cover 4-5 years	
	b) Dugong rescue and rehabilitation	Veterinary setup and mobile rescue teams	Infrastructure setup will be created with the help of State Forest Dept. & expert consultants	Full functionality during 4th-5th year project time frame after due experimentation and learning	Decline in mortality of stranded and injured dugongs	Increase in survivorship of rescued dugongs 4-5 years	Lack of infrastructure support Long term sustenance of rescue centre
	c) Documentation of Dugong conservation	Documentary film on Dugong and its habitats, their conservation and threats	Infrastructure support of State Forest Dept. Involvement of local communities	3rd- 5th year	Increased awareness on Dugong conservation issues around the range states Improved public perception of ecosystem services provided by Dugong & its habitats	Increased participation of local communities in conservation efforts 4-5 years	Lack of infrastructure support
3) Increasing participatory management of Dugongs	a) Incentives for rescue and release of entangled dugongs	Compensatory mechanism to motivate safe releases Training of Dugong Volunteer team for efficient rescues	Support of fishermen and state forest department	Sustained involvement from 2nd year onwards	Decline in mortality of entangled dugongs Increased participation of local communities	Increase in survivorship of rescued dugongs Higher reporting of entanglements 4-5 years	Lack of infrastructure support Unwillingness due to perception of threat to their livelihood.
	b) Incentivizing open sea enclosures	Compensatory mechanism to restrict use of enclosure Training of Dugong Volunteer team for efficient monitoring	Support of fishermen and state forest department	Sustained involvement from 2nd year onwards	Decline in incidental entanglement Improved habitat quality Increased participation of local communities	Improvement in habitat quality Improvement in population status of dugongs 4-5 years	Lack of infrastructure support Unwillingness due to perception of threat to their livelihood.

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Annexure- I

Budget and Cost Justification

Activity	Specifications	Amount (in Lakh rupees)					
		Yr1	Yr2	Yr3	Yr4	Yr5	Total
a) Man power	1 Project Scientist	6.7	7.4	8.1	8.9	9.8	41.0
	7 Project Fellow	26.9	29.6	32.5	35.8	39.4	164.1
	6 Field Assistants Grade-1	7.9	8.7	9.6	10.5	11.6	48.4
	6 Field Assistants Grade- 2	6.1	6.7	7.4	8.1	9.0	37.4
	Daily labour	1.0	1.1	1.2	1.3	1.5	6.1
	Project Management Unit (part cost)	15.4	10.5	11.5	12.6	13.9	63.9
Total Cost of Manpower Engagement		64.0	64.0	70.4	77.4	85.1	360.9
b) Capacity Building & Awareness	Capacity Building Training for State Forest Department personnel (Diploma/certificate or other trainings)	0.0	26.0	27.3	28.7	30.1	112.1
	Meetings, campaigns, workshops, preparation of awareness materials & management guides (3 events/state/year with approx. 20 participants/event)	15.0	15.8	16.5	17.4	18.2	82.9
	Specialised training for forest staff & local communities (1 training/state/year with approx. 10 participants/event)	36.0	37.8	39.7	41.7	43.8	198.9
	Documentary film on Dugong Conservation	0.0	0.0	25.0	5.0	5.0	35.0
Total Cost of Capacity building and Awareness		51.0	79.6	108.5	92.7	97.1	428.9
c) Participatory Management	Development and Participatory monitoring of Open-sea Enclosures	15.0	16.5	18.2	20.0	22.0	91.6
	Incentive-based rescue and rehabilitation of Dugong	30.0	30.0	30.0	30.0	30.0	150.0
	Strengthening Communication facilities for improved monitoring	30.0	33.0	36.3	39.9	43.9	183.2

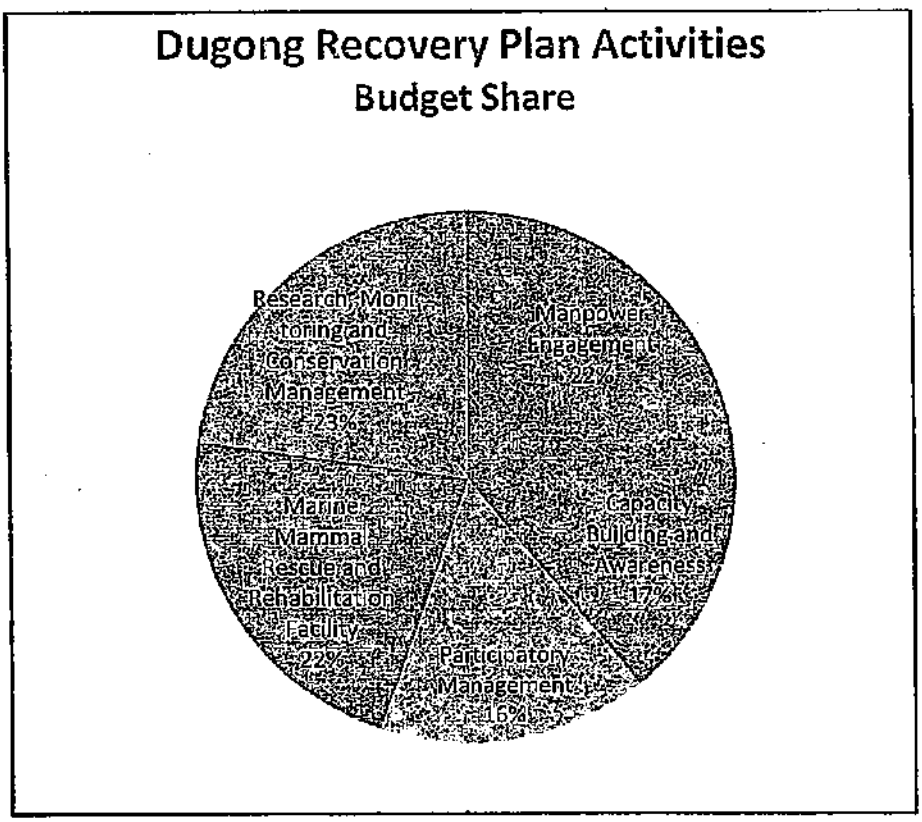
D

Total Cost of Participatory Management		**75.0**	**79.5**	**84.5**	**89.9**	**95.9**	**424.7**
d) Marine Mammal Rescue and Rehabilitation Facility	Establishment of MMRRF	0.0	5.0	5.0	120.0	120.0	250.0
	MMRRF running costs	0.0	0.0	0.0	12.0	12.6	24.6
	Miscellaneous costs	0.0	0.0	0.0	3.4	3.6	7.0
Total Cost of Marine Mammal Rescue and Rehabilitation Facility		**0.0**	**5.0**	**5.0**	**135.4**	**136.2**	**281.6**
e) Research, Monitoring, Species and Habitat Conservation and Management	Vehicle & POL (Four-wheelers)	15.0	15.8	16.5	17.4	18.2	82.9
	Vehicle & POL (Boat surveys)	54.0	56.7	59.5	62.5	65.6	298.4
	POL (Aerial surveys)	120.0	0.0	0.0	0.0	0.0	120.0
	Base Camp Establishment and Maintenance	6.6	3.9	4.1	4.3	4.5	23.4
	Travel & Accommodation	6.0	8.0	8.4	8.8	9.3	40.5
	Satellite telemetry	0.0	0.0	9.0	3.0	3.0	15.0
	Field/lab equipment & accessories	9.8	1.0	1.0	1.0	1.0	13.8
	Underwater &Onboard Monitoring Equipment	58.0	5.0	2.0	2.0	2.0	69.0
	Unmanned Aerial Vehicles / Drones	0.0	66.0	3.0	3.0	3.0	75.0
	Seagrass and benthic species monitoring	1.0	3.5	3.5	3.5	3.5	15.0
	Research/Conservation Genetics laboratory (genetics/pollutants) part cost	55.0	10.0	10.0	10.0	10.0	95.0
	Contingencies & Miscellaneous	2.0	3.0	3.0	3.0	3.0	14.0
Total Cost of Research, Monitoring and Conservation Management		**327.4**	**172.9**	**120.1**	**118.5**	**123.1**	**862.0**
GRAND TOTAL		**517.4**	**400.9**	**388.4**	**513.9**	**537.4**	**2358.0**

Annexure -II

Budget Summary

Activity	Amount (in Lakh rupees)					
	Yr1	Yr2	Yr3	Yr4	Yr5	Total
Manpower Engagement	64.0	64.0	70.4	77.4	85.1	360.9
Capacity Building and Awareness	51.0	79.6	108.5	92.7	97.1	428.9
Participatory Management	75.0	79.5	84.5	89.9	95.9	424.7
Marine Mammal Rescue and Rehabilitation Facility	0.0	5.0	5.0	135.4	136.2	281.6
Research, Monitoring and Conservation Management	327.4	172.9	120.1	118.5	123.1	862.0
GRAND TOTAL	517.4	400.9	388.4	513.9	537.4	2358.0



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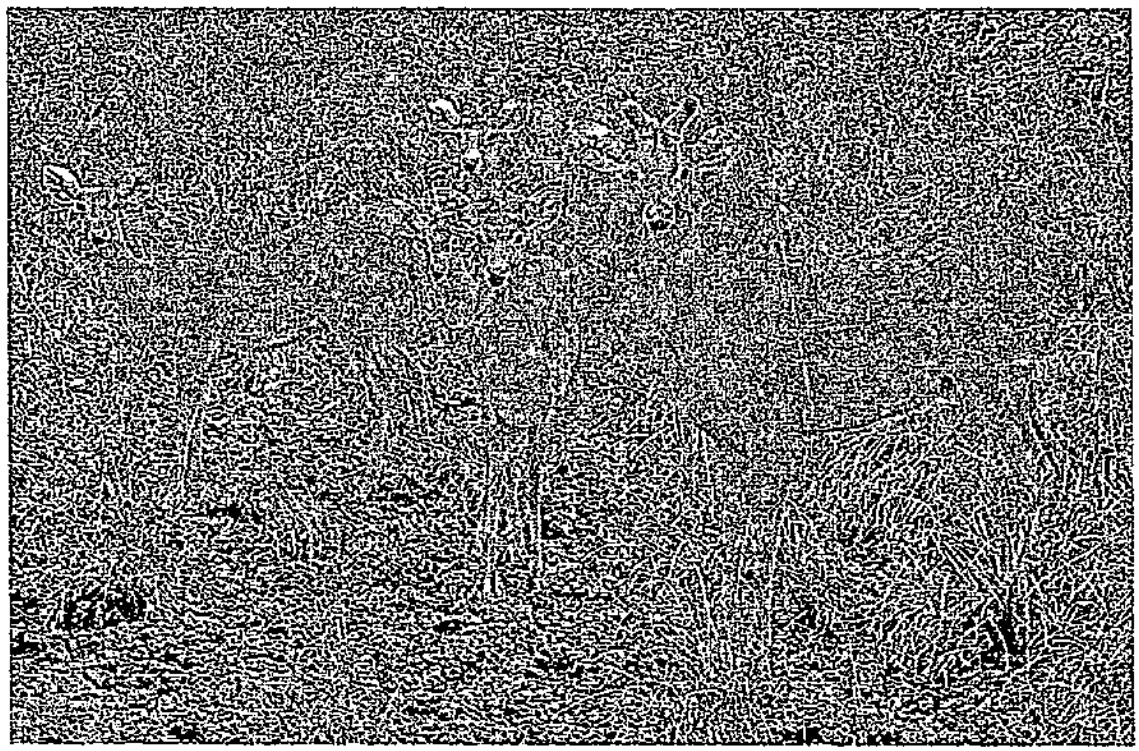
Annexure-IV

CONSERVATION ACTION PLAN FOR
Manipur's Brow antlered deer or Sangai: An integrated Approach



भारतीय वन्यजीव संस्थान
Wildlife Institute of India

August 2015

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	PROJECT PROPOSAL WILDLIFE INSTITUTE OF INDIA, POST BOX: 18, DEHRA DUN. 248001	
1.	Title of the project	Conservation action plan for Manipur's brow antlered deer or Sangai
2.	Name and address of the Implementation agencies	• Wildlife Institute of India, Dehra Dun • Ministry of Environment, Forest & Climate Change, Government of India, New Delhi • Forest Department, Government of Manipur, Imphal
3.	Project Duration	September 2015 – March 2020
4.	Total budget outlay	Rs. 19.95 crores

1. PROJECT BACKGROUND

1.1 *Distribution and status*

The Manipur's Brow Antlered deer or Sangai (*Rucervus eldii eldii*) occurs in wild only on the southern fringe of Loktak Lake in Manipur leading to the declaration of the Keibul Lamjao National Park (KLNP) and the beginning of intensive conservation efforts (Ranjitsinh 1975, Hussain et al. 2006). The initial population of Sangai was 14 individuals in 1975. During 2006-08, the population was estimated at less than 100 individuals (Hussain and Badola 2013) causing severe concern for its long-term survival.

The species is listed as "Endangered" on the IUCN Red List, Appendix I of the Convention on International Trade in Endangered Species (CITES), and Schedule I of the Indian Wild Life (Protection) Act, 1972 warranting immediate conservation actions. The Loktak Lake is a Ramsar site, and efforts are being made by the Wildlife Institute of India (WII) to declare it a World Heritage Site.

1.2 *Threats*

The Sangai population in India is single, small, isolated and therefore, subject to high risk of extinction due to stochastic, demographic and environmental events. Besides, the population is also under poaching pressure as the Park is located at the border of insurgency prone areas of India and Myanmar. Brucellosis and Tuberculosis are the common diseases among the livestock in the area that might have contaminated the Sangai population. Large scale mortalities such as those caused by the 1992 flood were also observed which led to 20% decline in the population (Hussain and Badola 2013). Additionally, the fawns are predated by wild pigs inside the Park, which might be negatively affecting the population.

The genetic study conducted by the WII (2009) suggests that the Sangai population in the Park is susceptible to inbreeding depression, decreased fitness and lesser evolutionary potential. The captive stock in Delhi, Guwahati and Manipur Zoos also indicated a significant loss of genetic diversity due to inbreeding depression. Therefore, for establishing a second genetically viable population, it is recommended that a minimum of 15-30 genetically effective founders be used from wild (Hussain & Badola 2013).

The habitat in the KLNP is deteriorating rapidly because of the changes in water regime due to the construction of the Ithai barrage. *Phumdis* or the floating meadows, which used to settle during lean season and get replenished, are now continuously floating, and are getting thinner and consequently becoming defunct in supporting the weight of the deer. The overall thickness of *phumdi* is decreasing at a rate of 9% per annum inside the Park, which will affect the survival of Sangai in the imminent future (Hussain and Badola 2013). To maintain the integrity of the floating meadows it is important to allow a major portion of the *phumdi* to settle down on the ground during lean seasons by reducing the water level of the lake and minimize burning, walking, trampling, resource extraction and grazing (Tuboi et al. 2012,

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Hussain and Badola 2013). The Loktak is also highly contaminated with sewage and has become hyper-eutrophic, affecting the life of other aquatic biota. Polluted water is also a cause of concern for the spread of disease that leads to Sangai mortalities as observed in the KLNP.

The Park is surrounded by 36 villages within a 3 km radius. Despite its protected status, the Park is under enormous pressure from resource extraction. A study conducted by the Wildlife Institute of India revealed that 7327 tons year^{-1} of plant biomass is extracted from the Park as vegetables, fodder and fuel. This biomass extraction contributes to 34-71% of the mean annual income of the local people. The extracted plant species overlapped with 43% of the food species of Sangai, thereby affecting the latter's food availability in the Park. There are no strict regulations imposed by the Park authorities owing to the lack of adequate staff and a clear-cut demarcation of the Park boundary (Badola and Hussain 2013).

As the existing Sangai population is growing within a restricted area without any scope for recolonization into the sinks, connectivity of the Park with its surrounding wetland and forest area needs to be identified and restored (Hussain and Badola 2013). The study conducted by the WII (2009) identifies thinning of *phumdi*, hyper-eutrophication, change in plant community composition, deterioration of water quality, heavy soil sediment and nutrient load, degradation of catchment area in combination with increased water level affecting the integrity of the Park (Angom 2012, Hussain and Badola 2013, Tuboi 2013). These problems need to be addressed immediately for the long term survival of Sangai and to maintain the integrity of the Loktak Lake ecosystem.

1.3 *Existing conservation measures*

The existing conservation measures for Sangai are largely directed to providing security to the species within the KLNP. A few village level institutions were also created, which are largely defunct now. The Park lacks suitable infrastructure and capacity. Very little effort has been made to mitigate the detrimental effects of the hydropower project in the Park, which could prove to be disastrous in the near future. While appropriate measures are being taken to improve the status of the Park, this action plan primarily deals with augmenting the Sangai population through improved conservation measures and by establishing a second population within the Manipur State. In 2009, the Wildlife Institute of India in association with Manipur Forest Department developed a 'Recovery Plan' for Sangai. The MoEF & CC approved Rs. 27 crores under the scheme 'Integrated development of wildlife habitat' and an amount of Rs. 1.3 crores was released in two instalments. Using this amount a Rescue Centre was built and some infrastructure was developed at KLNP.

2. GOALS AND OBJECTIVES

To secure the long term survival of Sangai in the wild, this proposal primarily addresses

a. strengthening of existing population in KLNP

b. establishment of second population in wild,
c. improved habitat condition and protection measures,
d. involving community in conservation efforts and
e. conducting applied research on the ecology of the species.

3. SCOPE OF WORK

In view of the deteriorating habitat quality of the KLNP and demographic structure of the Sangai population in the wild, the conservation action for the recovery of Sangai population should be in two stages working simultaneously. In the first stage, the existing population in the KLNP will be strengthened and habitat condition will be improved and in the second stage, a new population in the wild will be built through conservation breeding.

4. APPROACHES AND METHODOLOGIES

4.1 *Strengthening the existing population in KLNP*

Census will be conducted in alternate years to monitor the population trend in KLNP. Genetic monitoring of the wild and captive population will also be carried out using next generation sequencing. A veterinary lab will be established at KLNP to monitor diseases for which a Project Officer/Veterinary Officer will be appointed along with the required support staff to maintain the lab. Screening of domestic livestock around the Park for diseases will also be carried out.

4.2 *Establishment of second population in wild*

A rescue/conservation breeding centre will be established in Keibul where stocks that will be utilized for reintroduction will be maintained by capturing stray animals. The current captive stock at various zoos, including the Iroishemba Zoo at Imphal, also needs to be examined and matched with the wild population. Survey of the possible reintroduction site and development and demarcation of the site will be done. A soft release site will be developed first which will then be extended to a larger area and eventually the whole site will be developed and maintained. For this purpose, land acquisition from the local landowners will also be done.

The required construction work will be carried out by the Civil Construction Unit (CCU), who have a memorandum of understanding (MoU) with the Ministry of Environment, Forest and Climate Change (MoEF & CC), Government of India (GOI) and Wildlife Institute of India, Dehra Dun.

4.3 *Improved habitat condition and protection measures*

Fencing (chain-linked/ bund) will be constructed at vulnerable sites around the Park. Anti-poaching camps will also be constructed at these sites especially in the northern, eastern and southern side of the Park, which are more vulnerable to poaching as well as resource extraction. A year-round boat channel between Khordak and Toya, Khordak and Pabot and

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Pabot and Toya will be maintained to aid patrolling by the forest guards during the monsoon and early winter season, when the water level in the Park is high. Protection camps will be established at strategic location especially in Southeast side of the KLNP.

4.4 *Enhance community participation*

Ecodevelopment, livelihood options and awareness generation at KLNP and the reintroduction site will be conducted to gain community support in Sangai conservation. Since water level is a burning issue for the protection of the Sangai habitat in KLNP, and as it also affects the people living around the National Park, state-level stakeholder meetings for maintenance of water level will also be conducted.

4.5 *Promoting awareness and capacity building*

Training will be provided to the forest officials for better scientific management of the Park. The forest staff who are directly involved in the day to day protection of the Park will also be given training as well as provided with the necessary infrastructure required to strengthen their protection and monitoring activities in the Park. A management plan for the Park and the reintroduction site will be developed to assist in the management and long-term monitoring of these sites for the successful conservation of Sangai.

4.6 *Research and monitoring*

Apart from demographic and genetic monitoring the basic research and monitoring of the habitat in KLNP will be carried out so as to detect any change. The deterioration of habitat in the Park is due to the thinning of the floating meadows, *phumdis*. The water quality of the Loktak Lake has deteriorated due to pollutants entering the lake from Imphal and Bishnupur and as well as the surrounding landscape, both point and non-point sources. The other management-related research topics of interest include community structure and productivity of *phumdi*, water quality analysis and extent of pollutant load, disease and its impact on population, impacts of biomass extraction on the Park Ecology and the attitude of local people towards the Park.

5. CONSERVATION PROBLEMS AND PROPOSED SOLUTIONS IN LOG FRAME

In spite of several efforts, the population of Sangai is dwindling. The summary of factors affecting the long-term survival of the Sangai population in KLNP, Manipur is summarized in Table 1. Figure 1 & 2 gives the diagrammatic representation of problems faced by Sangai and the possible solutions in log frame. A detailed prescription for conservation action for with objectives and proposed activities with comments on each activity has been summarized in Table 2.

6. OUTPUTS/ OUTCOMES

The aforementioned management, capacity-building/awareness and research activities would secure a demographically and genetically secured population of Sangai in KLNP, a

demographically and genetically viable second population within its distribution range, and develop long-term community partners for the species' conservation. The primary outputs envisaged are:

a) Demographically and genetically secured population of Sangai in Keibul Lamjao National Park, India.
b) Demographically and genetically viable second population of Sangai within its distribution range in Manipur, India.
c) Collection of broachers, pamphlets and posters to sensitize the local communities and other stakeholders regarding the conservation issues of Sangai.

7. PROJECT OUTLAY

In 2009, the Wildlife Institute of India in association with Manipur Forest Department developed a Recovery plan for Sangai. The MoEF & CC approved Rs. 27 crores under the scheme Integrated development of wildlife habitat and an amount of Rs. 1.3 crores was released in two instalments. Using this amount a Rescue Centre at Keibul Lamjao has been built. However, due to the paucity of funds the allocation of the fund is uncertain, and MoEF & CC needs to find an alternative source of funds. The total project outlay for the current project is Rs. 19.95 crores as per the details given below. For the current financial year 2015-16 the MOEF & CC has sanctioned Rs. 1.3 crores.

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Table 1. Summary of the factors affecting Sangai population in Keibul Lamjao National Park, Manipur

Factors	Parameters	Consequences
Factor 1	Single small population	Susceptible to genetic drift and inbreeding depression
Factor 2	Declining population trend	Population is likely to lose it resilience to recover from stress
Factor 3	Poaching and incidental mortalities	Reduced population size
Factor 4	Deteriorating habitat due to change in water regime	Unable to support the existing population
Factor 5	Lack of connectivity between source and sink	Isolated population. No recolonization
Factor 6	Change in plant community structure	Decreased food availability and increased competition
Factor 7	Increasing biomass demand by the local communities	Increasing human wildlife conflicts
Factor 8	Degradation of water quality	Increased probability of disease
Factor 9	Contamination by pathogens and impact of catastrophe	Increased mortalities
Factor 10	Poaching and incidental mortalities	Reduced population size

Figure 1. Analysis of problems affecting the long term survival of Sangai

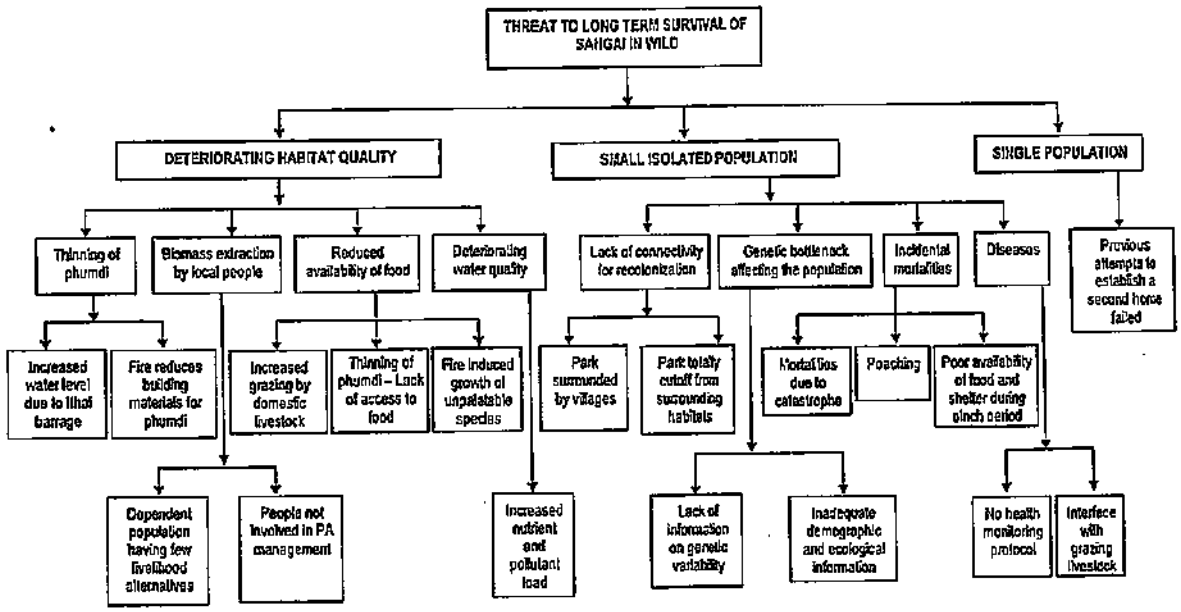

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Figure 2. Solutions for the long term survival of Sangai

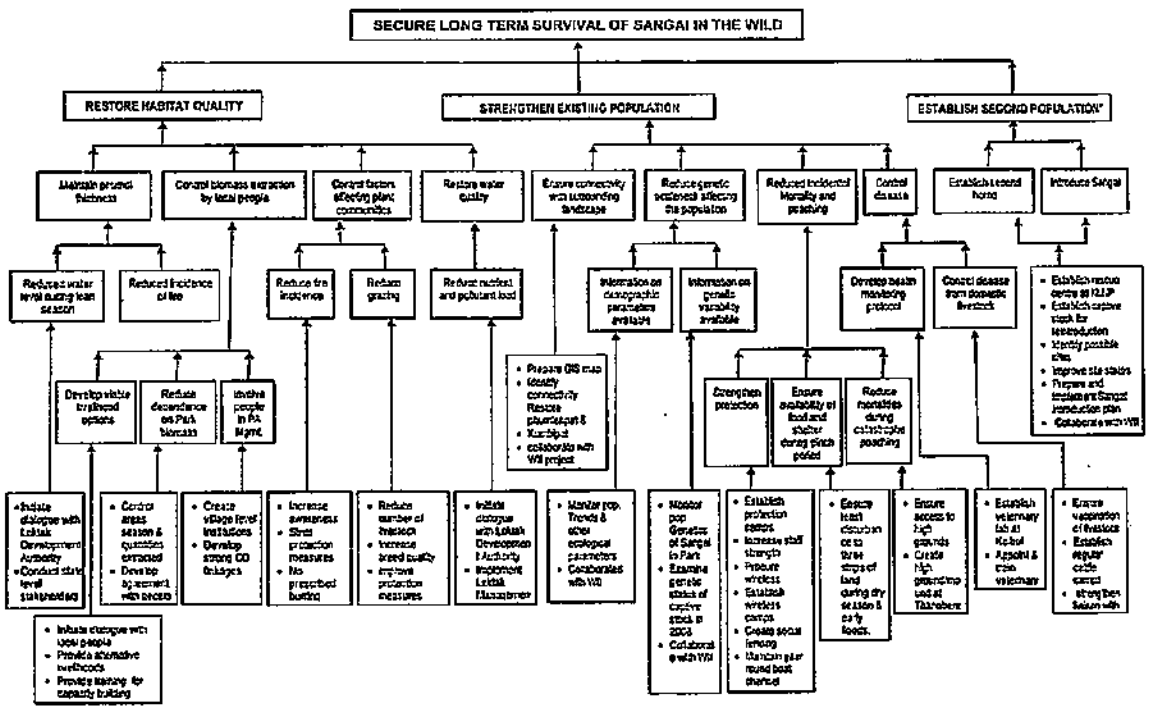

Table 2. Species recovery plan of Sangai in Logical Frame Work

Parameters	Objectively Verifiable Indicators (OVI)	Means of Verifications (MOV)	Assumptions/Pre-requisites
GOAL			
To secure long term survival of Sangai in the wild	Established viable population of Sangai in its range	Demographic parameters of the population Recruitment in established population achieved	Sustained government and public support for implementation of the plan. Continuous and sustained flow of funds. Adequate staff for implementation of the plan
OBJECTIVES			
1. To restore habitat quality in KLNP	Productivity of Park enhanced >50% from existing rate	Monitoring productivity	Habitat restoration as proposed undertaken and adequate fund was made available
2. To strengthen existing population in KLNP	Targeted population size of >200 achieved	Conduct population monitoring	Intervention as proposed undertaken to remove the factors affecting population
3. To establish second population in wild	Recruitment in the second population achieved	Monitoring of demographic and genetic status of the reintroduced population	Funds made available to improve the site for establishment of second population
EXPECTED OUTCOME			
1.1 *Phumdi* thickness maintained at desired level	Occupancy of Sangai increased in gap areas of the Park	Monitoring of dung distribution in the Park	Provided that the desired structural changes in the *phumdi* takes place
1.2 Extraction of biomass controlled	Biomass extracted from the Park declined	Door to door survey	No new population immigrates in the area
1.3 Factors affecting plant communities controlled	Original community (Gee 1962) restored on thick *phumdi*	Examining plant communities	Other ecological parameter affecting plant communities
1.4 Water quality restored	Water quality restored to prescribe standard	Check DO, N & P	Integrated pollution control program for the Manipur valley

Parameters	Objectively Verifiable Indicators (OVI)	Means of Verifications (MOV)	Assumptions/Pre-requisites
			implemented
2.1 Connectivity with surrounding landscape ensured	Hog deer and Sangai started using connectivity	Examine presence of dung	Land for establishing connectivity available
2.2 Genetic bottleneck of the population reduced	High genetic variability in the population	Monitor population genetics	Adequate samples for genetic study available
2.3 Incidental mortality, mortality due to wild boar predation and poaching controlled	Examine demographic structure	Conduct population monitoring	People are proactive in providing information of poaching. Protection plan is strictly adhered to
2.4 Mortalities due to disease controlled	Number of cases of mortalities due to diseases declined	Periodic monitoring of Park	Veterinary monitoring protocol is in place
3 1 Second population established	Recruitment in the second population achieved	Monitoring of introduced population	Area available for second home
EXPECTED OUTPUTS			
1.1.1 Water level during lean seasons reduced	Thickness of *phumdi* increased	Monitor *phumdi* thickness	There is consistently high rainfall
1.2.1 Viable livelihood options adopted	Extraction of biomass reduced	Conduct entry point monitoring	Adequate funds available
1.2.2 Dependence of local people on Park reduced	Extraction of biomass reduced	Conduct entry point monitoring	Viable livelihood options adopted
1.2.3 People involved in PA management	Number of village level consultative meetings held	Records of village level institutions	Effective village level institutions created
1.1.2 Fire incidents reduced	No cases of fire in the Park	Examine patrolling and fire records	Fire management plan implemented
1.1.2 Grazing controlled	Reduced evidence of grazing in the Park	Examine patrolling records	Grazing controlled
1.4.1 Nutrients and pollutant load reduced	Reduced N & P and reduced pollutants level	Check water quality periodically	Loktak Management Plan implemented

Parameters	Objectively Verifiable Indicators (OVI)	Means of Verifications (MOV)	Assumptions/Pre-requisites
2.2.2 Data on demographic parameters derived	Population monitoring conducted every alternative year	Check population monitoring report	Logistic and financial support for population monitoring made available at appropriate time
2.2.3 Information on genetic variability made available	Genetic analysis of population conducted	Check genetic monitoring report	Information obtained is used for scientific management of the population
2.3.1 Protection strengthened	Cases of illegal entry, grazing and poaching reduced	Check patrolling records	People are proactive
2.3.2 Food and shelter ensured during pinch period	Use of identified areas increased	Monitor dung density	Climatic factors not a constraint to habitat recovery
2.3.3 Mortalities during catastrophe controlled	No case of mortalities during flood	Increase patrolling during monsoon	Access to high ground during flood provided
2.4.1 Health monitoring protocol implemented	Examination of samples collected	Conduct health assessment of Sangai	Health monitoring plan implemented
2.4.2 Disease outbreak due to interface with domestic livestock controlled	Reduced incidence of common disease in livestock	Check veterinary department records	Health monitoring plan implemented
PROPOSED ACTIVITIES			
1.1.1 Conduct state level stakeholder meeting	State level held at least every 6 months	Check proceedings	Institutional framework for project implementation is in place. Management plan is prepared and implemented.
1.2.1 Initiate dialogue with local people	Village level consultative meetings takes place	Check records of village institutions	
1.2.2 Provide alternative livelihoods	Alternative livelihood plan prepared and implemented	Conduct social survey	
1.2.2 Control areas, season & quantities extracted	Extraction of biomass reduced	Monitor entry points	
1.2.3 Develop agreement with people & implement	MOU signed	Check proceedings	

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Parameters	Objectively Verifiable Indicators (OVI)	Means of Verifications (MOV)	Assumptions/Pre-requisites
1.2.3 Create village level institutions	Village level institutions created	Check society registration number	
1.2.3 Develop Conservation-Development linkages	People proactive in conservation	Social survey	
1.3.1 Increase awareness	Number of awareness camps held	Records and awareness material developed	
1.3.1 Reduce prescribed burning	Extent of burning reduced	Check daily activity records	
1.3.1 Create fire lines	Extent of fire	Check patrolling records	
1.3.2 Reduce number of livestock	Number of livestock in the villages	Livestock census	
1.3.2 Increase breed quality	Livestock breed	Village survey	
1.3.2 Improve protection measures	Decreased human wildlife conflict	Check records	
1.3.3 Develop agreement with local people	MOU with local level institutions signed and implemented	Check records	
1.4.1 Initiate dialogue with Loktak Development Authority	Consultative meetings held	Check records	
1.4.1 Implement Loktak Management plan	MOU with LDA signed and decision implemented	Check records	
2.2.1 Prepare GIS map and identify connectivity	Examine study report		
2.2.1 Restore Pumlen pat & Kumbi pat	Increased evidence of animal use	Dung survey	
2.2.1 Collaborate with WII for GIS analysis	MOU signed and implemented	Check records	
2.2.1 Monitor population trends	Examine study report	Check records	
2.2.1 Monitor food and activity pattern of Sangai	Examine study report	Check records	

Parameters	Objectively Verifiable Indicators (OVI)	Means of Verifications (MOV)	Assumptions/Pre-requisites
2.2.1 Collaborate with WII, transfer funds to WII	MOU signed and implemented	Check records	Financial and logistic support and trained human resource is available for implementation. Cooperation of stakeholders including Loktak Development Authority, local institutions and line agencies is mobilized.
2.2.3 Monitor population genetics of Sangai	Examine study report	Check records	
2.2.3 Examine genetic status of captive stock	Examine study report	Check records	
2.2.3 Collaborate with WII, transfer funds to WII	MOU signed and implemented	Check records	
2.3.1 Establish protection camps	At least 12 protection camps established	Number of protection camps	
2.3.1 Increase staff strength	staff strength increased as proposed	Number of staff	
2.3.1 Procure wireless	Wireless equipment procured	No. of working wireless sets	
2.3.1 Establish wireless camps	At least 12 wireless camps established	No. of wireless camps	
2.3.1 Create social fencing	MOU with village level institutions	Check records	
2.3.1 Maintain year round boat channel	Boat channel kept free of *phumdi*	Survey	
2.3.1 Procure boats for movement	Number of boat available with department	Check records	
2.3.1 Institutionalize patrolling	Patrolling camps and routes established	Check patrolling record	
2.3.2 Ensure least disturbance in high grounds	Cover maintained and restricted human interference	Survey	
2.3.2 Stop burning of these three strips of high land	Adequate cover maintained	Survey	
2.3.2 Ensure access to high grounds	High ground with adequate cover kept disturbance free	Survey	

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Parameters	Objectively Verifiable Indicators (OVI)	Means of Verifications (MOV)	Assumptions/Pre-requisites
2.3.2 Create high ground/mound at Thangbirel	High ground/mound at Thangbirel created	Survey	
2.4.1 Establish veterinary lab at Keibul	Veterinary lab at Keibul established	Functional lab in place	
2.4.1 Appoint & train veterinary officer	Veterinary officer appointed and trained	Veterinary lab in place	
2.4.2 Ensure vaccination of livestock	Regular vaccination camps established	Check records	
2.4.2 Establish regular cattle camps	Regular vaccination camps established	Check records	
2.4.2 Strengthen liaison with veterinary department	MOU developed and implemented	Examine MOUs	
3.1.1 Establish rescue centre at KLNP	Rescue centre established	Functional rescue centre is in place	Sangai reintroduction plan is prepared and implemented
3.1.1Establish captive stock for reintroduction	Number of Sangai rescued and placed at the rescue centre	Captive stock in place at the ratio of 1:2 (male female)	
3.1.1 Identify possible sites	Site evaluation report	Report	
3.1.1 Improve reintroduction site status	Habitat status	Survey	
3.1.1. Prepare and implement Sangai introduction plan	Sangai introduction plan	Plan	
3.1.1 Collaborate with WII & develop protocols	MOU developed and implemented	MOU in place	

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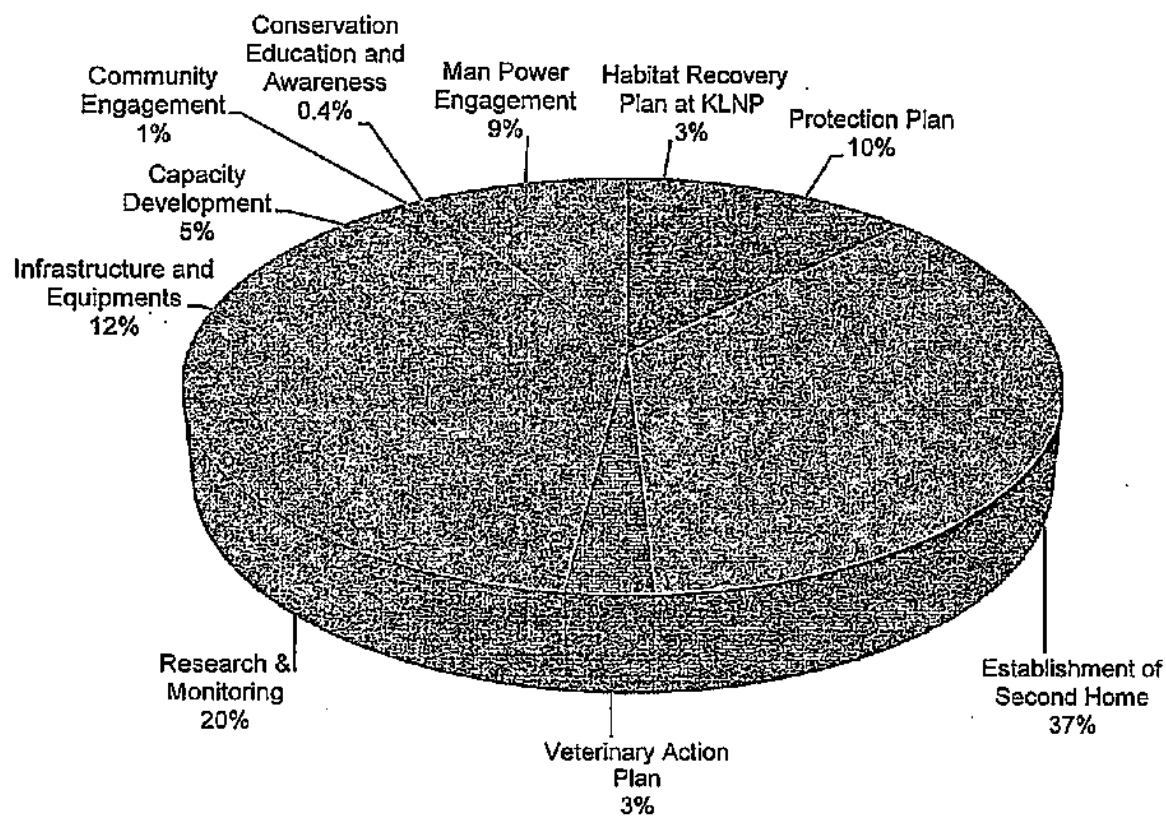
9. SUMMARY OF BUDGET

#	Account Heads	Amount (Rupees in Lakhs)					
		Yr 1	Yr 2	Yr 3	Yr 4	Yr 5	Total
1	Habitat Recovery Plan at KLNP	13	25	15	5	5	63
2	Protection Plan	3	70	65	50	0	188
3	Establishment of Second Home	15	330	215	85	85	730
4	Veterinary Action Plan	7	20	20	5	5	57
5	Research & Monitoring	40	110	110	80	65	405
6	Infrastructure and Equipments	19.01	108.6	65.6	27.6	24.6	245.41
7	Capacity Development	4	35	35	15	15	104
8	Community Engagement	2	5	5	5	5	22
9	Awareness generation	2	2	1	1	1	7
10	Man Power Engagement	25.3	37.1	37.2	37.3	37.5	174.4
	GRAND TOTAL	130.4	742.7	568.8	310.9	243.1	1995.9

10. DISTRIBUTION OF BUDGET ACROSS CONSERVATION ACTIONS



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11. DETAILED BREAK UPS OF THE BUDGET

Account	Specifications/Cost-calculation	Amount (Rs. in Lakhs)					
		Yr 1	Yr 2	Yr 3	Yr 4	Yr 5	Total
1. HABITAT RECOVERY PLAN AT KLNP							
	Conduct state level stakeholder meetings for reduction of water level (travel and accommodation cost included)	10	10	0	0	0	20
	Ecodevelopment at KLNP (sustainable livelihood options x 36 villages)	3	15	15	5	5	43
	TOTAL	13	25	15	5	5	63
2. PROTECTION PLAN							
	Creation of fencing (chain-linked/bund) at vulnerable sites	0	50	50	50	0	150
	Construction of anti-poaching camp at reintroduction site	0	15	15	0	0	30
	Procurement of 6 boats for movement in the Park and Reintroduction site	2	4	0	0	0	6
	Procurement of two motorcycle	1	1	0	0	0	2
	TOTAL	3	70	65	50	0	188
3. ESTABLISHMENT OF SECOND HOME							
	Development of rescue/conservation breeding centre at Keibul	5	30	30	30	30	125
	Survey and demarcation of possible reintroduction site.	5	15	5	0	0	25
	Development of reintroduction site	0	30	30	20	20	100
	Acquisition of additional land for reintroduction	0	200	100	0	0	300
	Development of soft release site	0	10	5	0	0	15
	Construction of fencing/Bund at reintroduction site	0	25	25	0	0	50
	Ecodevelopment at the reintroduction site (sustainable livelihood options in surrounding villages)	5	20	20	5	5	55
	Introduction of Sangai and associated expenses (transportation cost etc)	0	0	0	30	30	60
	TOTAL	15	330	215	85	85	730
4. VETERINARY ACTION PLAN							
	Establish veterinary lab at Keibul	2	15	15	5	5	42
	Purchase of veterinary equipment	5	5	5	0	0	15
	TOTAL	7	20	20	5	5	57
5. RESEARCH & MONITORING							0
	Monitoring of population trend	5	5	5	5	5	25
	Monitoring of population genetics of wild and captive stock (equipment part cost	15	20	20	20	5	80

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Account	Specifications/Cost-calculation	Amount (Rs. in Lakhs)					
		Yr 1	Yr 2	Yr 3	Yr 4	Yr 5	Total
	including consumables etc)						
	Disease and parasite investigation	2	10	10	5	5	32
	Investigate stress in captive and wild stocks	0	10	10	10	10	40
	Monitor habitat quality (Water quality, pollutant, productivity)	0	10	10	10	10	40
	Research and monitoring at the Reintroduction site	2	25	25	10	10	72
	Social survey KLNP & at Reintroduction site	2	15	15	5	5	42
	Travel	10	10	10	10	10	50
	Contingency including expendable	4	5	5	5	5	24
	TOTAL	40	110	110	80	65	405
6. INFRASTRUCTURE AND EQUIPMENTS							
	Project Office at Keibul/Building to be provided by the Department	1	20	20	5	5	51
	Office equipment	1	6	5	3	0	15
	Communication	1	1	1	1	1	5
	POL/maintenance	3	10	10	10	10	43
	Contingency	1	1	1	1	1	5
	Hiring of Vehicles	3.6	3.6	3.6	3.6	3.6	18
	Field Equipments	8.41	0	0	0	0	8.41
	Lab equipments	0	13	0	0	0	13
	Survey equipments	0	4	0	0	0	4
	Electric fencing	0	50	25	4	4	83
	TOTAL	19.01	108.6	65.6	27.6	24.6	245.41
7. CAPACITY DEVELOPMENT							
	Training of Officers and staff (Diploma, certificate at WII and other trainings)	0	10	10	10	10	40
	Strengthening of staff welfare activities	4	15	15	5	5	44
	Management planning of KLNP & Reintroduction site	0	10	10	0	0	20
	TOTAL	4	35	35	15	15	104
8. COMMUNITY ENGAGEMENT							
	Participation and sensitization of local communities	2	5	5	5	5	22
9. CONSERVATION EDUCATION AND AWARENESS							
	Awareness and education meetings to be organized in KLNP & Reintroduction site	2	2	1	1	1	7

Account	Specifications/Cost-calculation	Amount (Rs. in Lakhs)					
		Yr 1	Yr 2	Yr 3	Yr 4	Yr 5	Total
10. MAN POWER ENGAGEMENT							
	Establishment of second home, habitat recovery & veterinary action plan						
	Project Scientist	6.72	7.4	8.1	8.9	9.8	41.0
	Project Associate x 2 nos (1 Population Management from 1st year + 1 Veterinary Officer from 2nd year)	5.42	11.9	13.1	14.4	15.9	60.8
	Project Fellow 2 + 2 nos (1 ecologist + 1 sociologist in the first year and additional 1 environmentalist + 1 ecologist from 2nd year onward)	7.68	16.9	18.6	20.4	22.5	86.1
	Forests Guard cum animal keeper x 2 nos from the 2nd year onwards for Rescue centre	0	2.4	2.6	2.9	3.2	11.1
	Support staff x 2 (1 in the 1st year + additional 1 from 2nd year onwards for rescue centre and veterinary lab)	1.2	2.6	2.9	3.2	3.5	13.5
	Field Assistant Grade 2 x 2 nos (2 nos in the first year)	2.4	2.6	2.9	3.2	3.5	14.7
	Field Assistant Grade 1 x 2 nos (from the 2nd year onwards)	0	1.5	1.7	1.8	2.0	7.0
	Part cost of Project Management Unit	1.9	1.3	1.4	1.6	1.7	8.0
	TOTAL	25.3	37.1	37.2	37.3	37.5	174.4
	GRAND TOTAL	130.4	742.7	568.8	310.9	243.1	1995.9

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भारतीय वन्यजीव संस्थान
Wildlife Institute of India

No. WII/EPPM/AKB/CAMPA/Proposals

Dated: 16 August, 2015

To,

Shri B.K. Singh,
Director, Ad-hoc-CAMPA,
Ministry of Environment, Forest and Climate Change,
Indira Paryavaran Bhawan,
JAL Wing, Jorbagh Road,
New Delhi – 110003.
Fax: 011-24695340.
Email: adhoc-campa-mef@nic.in, bksbishwajitifs@yahoo.in

Sub.: Minutes of the 6th Meeting of the National CAMPA Advisory Council, New Delhi held on 8th July, 2015 – reg.

Ref.: (i) Our letter of even number dated 27th June 2015 and 7th July, 2015
(ii) MoEFCC letter No. 13-16/2012-CAMPA, dated 9th January 2015 forwarding minutes of 5th Meeting of the National CAMPA Advisory Council and MoEFCC letter No. 13-28/2015-CAMPA, dated 21 July, 2015 forwarding minutes of 6th Meeting of the National CAMPA Advisory Council

Sir,

With reference to the above, please find enclosed herewith the revised final proposal as per the details given below for the funding under National CAMPA Advisory Council:

Sl. No.	Name of the project	Duration of project	Total 5 year Cost (in Rs. crores)	Year I release (in Rs. crores)	Annexure
1	Habitat improvement and conservation breeding of the Great Indian Bustard: An Integrated Approach	5 years	33.85	9.95	Annexure-I
2	Development of Conservation Action Plan for River dolphins (*Platanista gangetica gangetica*)	5 years	23.00	4.60	Annexure-II
3	Recovery of Dugongs and Their Habitats in India: An Integrated Participatory Approach	5 years	23.58	5.17	Annexure-III
4	Conservation of Manipur's Brow antlered deer or Sangai: An Integrated Approach	5 years	19.95	1.30	Annexure-IV
		Total	100.38	21.02	

Thanking you.

Yours faithfully,

(Dr. V.B. Mathur)
Director

Encl.: As above

Cc.: (1) PPS to Director General of Forests & Special Secretary to Government of India, Ministry of Environment, Forest and Climate Change, Jal Wing, Indira Paryavaran Bhawan, Jor Bagh Road, Aliganj, New Delhi-110003. Email: dgfindia@nic.in, sharad.negi@nic.in

(2) Dr. M.S. Negi, Inspector General of Forests (FC), Ministry of Environment, Forest and Climate Change, Agni Wing, Indira Paryavaran Bhawan, Jor Bagh Road, Aliganj, New Delhi-110003. Email: negims84@hotmail.com

(3) PPS to Additional Director General of Forests (Wildlife), Ministry of Environment, Forest and Climate Change, Jal Wing, Indira Paryavaran Bhawan, Jor Bagh Road, Aliganj, New Delhi-110003. Email: adgwl-mef@nic.in, vinodranjan56@gmail.com

(4) Dr. S.K. Khanduri, Inspector General of Forests (Wildlife), Ministry of Environment, Forest and Climate Change, Indira Paryavaran Bhawan, Jor Bagh Road, New Delhi-110003. Tel: 011 2469 5269. Fax: 011 2469 5291. Email: igfwl-mef@nic.in

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Annexure-I

Project title: **Habitat Improvement and Conservation Breeding of the Great Indian Bustard: An Integrated Approach**

Implementation agencies:
(1) Wildlife Institute of India
(2) Forest Departments – Rajasthan, Gujarat, Maharashtra

Collaborating agencies:
(1) Bombay Natural History Society
(2) The Corbett Foundation
(3) World Wide Fund for Nature

Budget: Rs. 33.85 crores

Timeline: September 2015 – December 2020

भारतीय वन्यजीव संस्थान
Wildlife Institute of India

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1. Project background

Great Indian Bustard *Ardeotis nigriceps* (henceforth GIB) is one of the rarest birds in the world. With ~200 individuals left, almost exclusively in India, the species is listed as Critically Endangered (IUCN 2011) and Schedule I (the highest protection status, Wildlife (Protection) Act, 1972). Their populations have steadily declined by 75% in last 30 years and are facing imminent extinction risk unless serious management interventions are applied (Dutta et al. 2011). Historically, GIB was distributed throughout the western half of India, but, currently they are found in five fragmented pockets. According to our recent population assessment (Dutta et al. 2015), the largest population of 169±70 birds occurs in Thar landscape of Rajasthan (Desert National Park in Jaisalmer alongside Jodhpur). The other populations are <15 birds each, occurring in Gujarat (Lala-Naliya Sanctuary and its neighbourhood in Kachchh), Maharashtra (Bustard Sanctuary in Solapur, alongside Chandrapur and Nagpur), Andhra Pradesh (Rollapadu Sanctuary and its neighbourhood in Kurnool) and Karnataka (Bellary) (Dutta et al. 2011).

Research shows that GIB is an omnivorous bird primarily feeding on insects, fruits, and harvested crops. They live in dry, open landscapes comprising short grasslands, open scrub, and rain-fed agriculture. They are traditional to their breeding grounds, where, males display in open, well-grazed grasslands to attract females who prefer moderately tall and less-grazed grassland for nesting. Thus, a mosaic of short and tall vegetation with little disturbance is ideal for breeding. Their non-breeding usage is vast and distributed across well-connected, productive areas with short fruiting shrubs and fallow fields. However, their seasonal movement patterns and critical resource requirements for nesting, chick-rearing and lekking are complex and poorly understood. Existing research on GIB and related species shows that large heterogeneous agro-grassland patches have highest conservation value (del Hoyo et al. 1996). Although these birds are intolerant to intensive development, they are compatible with traditional, low-intensity land uses that can create some win-win conservation situations (Dutta and Jhala 2014).

The species has declined due to compounding effects of direct and indirect human exploitations on their slow life-history traits. They were subjected to exhaustive hunting and egg collection in the past that reduced their population to ~1260 birds in 1969 (Dharmakumarsinhji 1971). They are still hunted in Pakistan where birds from India perhaps migrate seasonally, and also in Thar, Rajasthan. However, their contemporary decline is largely due to prevailing habitat loss as dry grasslands have been marginalized as 'unproductive wastelands' and progressively converted to other land uses since colonial times. Recent developments in irrigation and farming technologies have intensified agriculture in bustard habitats and changed cropping practices from seasonal to year-round, intensive crops. This has led to food scarcity, pesticide contamination, and habitat loss. Development activities like mining, industries, power projects, wind turbines, and associated infrastructure growth (buildings, electricity and road networks) have caused severe habitat degradation and disturbance to birds. Being low and heavy flyers, they face a high risk of fatal collisions with power-lines that are difficult to detect from afar. Feral dog populations have increased in their habitats, and along with native predators (fox, mongooses, and cats), they have increased predation pressure on nests and chicks and reduced recruitment. Past efforts of banning human activities to create bustard Sanctuaries over large human-use landscapes, without appropriate settlement

of land rights, have generated bitterness among local people, lack of conservation support, and backlash. These factors have in turn to local extinctions from some Sanctuaries. Local people and managers are not sufficiently aware of the conservation benefits of grasslands and the scientific ways to manage them. While, the traditional ways to manage these habitats are eroding due to rapid socio-ecological changes driven by state policies (Dutta et al. 2013). Although most remaining breeding habitats are protected to some level, the vast movements of bustards expose them to the threats mentioned above in the non-breeding habitats, defeating the purpose of protecting small breeding reserves. Since these large bustard landscapes cannot be freed from human uses, a mixed approach of Protected Area based conservation of breeding habitats and coexistence with compatible human land uses in adjoining landscapes best suits the situation. Effective conservation of these landscapes would require information on species' ranging patterns, relative magnitudes and distribution of threats, and ways to reconcile the species' ecological needs and livelihood concerns that are poorly known. Furthermore, management authorities in many areas exhibit poor enforcement ability due to inadequate staff and infrastructure, lack of motivation, and inaccessibility.

Concerned about the extinction crisis of GIB, Indian conservation circles have proposed the Government to adopt strategic recovery plans for the species as a flagship of dry grasslands. In light of these issues, the National Guidelines for Bustard Recovery Plans (Dutta et al. 2013) strongly recommend filling research gaps, improving habitat, improving enforcement capacity, and engaging communities in conservation. However, the implementation of in-situ conservation measures require some gestation time, but, the population size of GIB (with no birds in captivity) is too small to sustain such delays. Thus, a captive population needs to be secured for supplementing wild populations and reintroducing birds into restored habitats in favorable times.

We propose an overarching project that integrates all these components into a holistic conservation plan for the priority bustard landscapes of Rajasthan, Gujarat, and Maharashtra. The proposed activities will be undertaken in collaboration with State Governments, local NGOs, and research organizations so as to pool knowledge/expertise and ensure timely and effective implementation. Since both the endangered bustards of dry grasslands – great Indian bustard and lesser florican – share habitats, these activities will supplement and complement each other's needs. In doing so, habitats that support a plethora of other endangered wildlife, such as the spiny-tailed lizard *Saara hardwickii*, chinkara *Gazella bennettii* and foxes *Vulpes* spp, will be restored.

2. Goals and objectives

The broad goals and objectives of this project are as follows:

- **Conservation Breeding**

Developing and running Conservation Breeding Center to secure captive populations of great Indian bustard and (if needed) lesser florican as insurance against extinction and (if possible) subsequent reintroduction into restored habitats

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- **Applied research**

Undertaking targeted research for:

a) prioritizing conservation areas, b) characterizing threats, c) monitoring populations and habitats to assess the effectiveness of management actions, d) assessing local communities' livelihood concerns and willingness to adopt bustard-friendly land uses, and e) comprehensive understanding of population genetics to inform conservation management

- **Capacity-building and awareness**

a) Improving protection enforcement through training of Forest staff and implementation of technology aided patrolling , b) sensitizing decision-makers, managers and local communities on bustard conservation, c) raising public awareness and support for bustard conservation through awareness materials, and d) incentivizing local land users to adopt bustard-friendly land uses

- **Pilot implementations for surgical habitat management**

Demonstrating best practices for habitat improvement through pilot/experimental surgical interventions that will be subsequently replicated by State Forest Departments

3. Scope of work

Conservation breeding

The Ministry of Environment, Forests and Climate Change (henceforth MoEFCC) has decided to commence a national Conservation Breeding Programme for GIB to secure an insurance population. These captive birds can be reintroduced into restored habitats if conditions are favorable in future. This program will involve State Governments of Rajasthan, Gujarat and Maharashtra as the main partners, and will be supervised by the Wildlife Institute of India. The National CAMPA funds will be utilized in setting up the infrastructure for this Captive Breeding Facility in the first four years, running it for 25-30 years, and subsequently releasing and monitoring the birds between 30-35 years. The roadmap for this activity has been broadly outlined through consultative workshops, but a detailed program plan has to be developed through collaboration with expert agencies or personnel in the first two years of the project. Given the critically endangered status of the species, this program should not be treated as a trial but a fully fledged activity with cutting-edge infrastructure and expertise. For smooth functioning, sustained financial support, respective roles/responsibilities, and cooperation between the stakeholders, a project document or memorandum of understanding needs to be formulated in consensus with partner agencies.

Applied research

Existing/potential bustard habitats have to be identified for conservation management and objectively monitored to assess management effectiveness. This entails developing and implementing systematic and scientific surveys across the ranges of great Indian bustard and lesser florican to generate baseline information on their population parameters and monitor their changes over space and time.

Bustards undertake wide movements across large landscapes that cannot be entirely conserved. Although birds are protected within small breeding reserves, they are exposed to various emerging threats during such movements in unprotected landscapes. Bustard conservation will only be successful if these threats are mitigated at the landscape-level. This requires information on ranging patterns of many birds from different landscapes so that intensively used areas, and connectivity corridors/flyways can be identified and prioritized for conservation investment and minimization of development. The advent of satellite telemetry has opened up a new horizon for remotely monitoring movement patterns of such wide-ranging species. Such information can be analyzed to prioritize development vs. restrictive-use zones.

In addition to understanding bird movements, spatial distributions of multiple threats and their relative impacts on bustard need to be characterized for effectively mitigating threats at landscape-scale. Therefore, research aimed at mapping of power-line networks, pesticide-prevalence, and dog densities are required across landscapes.

Finally, there is a need to understand the genetics of bustard populations to manage them effectively. A study based on mitochondrial DNA suggested very low genetic diversity and effective population size and indicated no phylogeographic structure of great Indian bustard females across the country (Ishtiaq et al. 2011). These inferences need to be strengthened with further evidence based on nuclear microsatellite markers. Nuclear microsatellite markers provide information on both genders, and since they have a higher mutation rate when compared to mitochondrial DNA, they can reflect recent demographic events of conservation importance. Thus, a combination of mitochondrial and nuclear marker-based approaches will provide holistic inferences on processes affecting bustard populations that cut across demographic classes and time scales. These combined inferences entail a comprehensive understanding of a) whether populations are disconnected or continue to exchange individuals; b) the rate and direction of such genetic exchange and how that is influenced by distance, demography and anthropogenic factors; c) the degree and timing of genetic bottlenecks and other demographic events experienced by the remaining populations; d) the ecological/geological processes that have shaped the past and present genetic structure/composition; and e) how to conserve the present genetic diversity in wild and captive populations. Understanding these aspects have strong implications on both in-situ and ex-situ management. The rarity and sparse distribution of GIB preclude precise population assessment through observation-based approaches (discussed in Dutta et al. 2015). Therefore, another potential and important application of genetics would be to integrate molecular identification of individuals with spatial capture-recapture models to obtain precise estimates of local (small-scale) population abundances. However, some of the above questions might be difficult to answer at this moment considering the rarity of bustards that constraints collection of adequate genetic samples and the unavailability of historical samples.

Capacity-building and awareness

a) To strengthen protection measures across large GIB landscapes, patrolling ability of Forest Department needs to be improved by recruiting an adequate number of trained forest guards. It has been

noted that frontline staff in GIB landscapes have very low motivation and capacity to enforce law partly because of the harsh and remote field conditions of these areas. Their performance needs to be significantly enhanced by providing better incentives, appropriate training, necessary infrastructure and equipment, and establishing information and vigilance networks through regular communication with local people.

b) Bustards share their habitats with multiple stakeholders: local communities who depend on these habitats for subsistence; forest department that is empowered to protect these habitats; government officers from revenue, agriculture, animal husbandry, dairy and power departments whose agendas might be in conflict with the interest of bustard conservation; and private industrialists whose activities might be degrading these habitats. The key stakeholders in each of the bustard landscape have to be identified and sensitized through meetings and workshops to make them aware of the ecological hazards of unplanned development in grasslands.

c) Local people depending on bustard habitats for subsistence needs have to be encouraged to opt for agro-environmental schemes that incentivize bustard-friendly practices to balance conservation and livelihoods. Some bustard-friendly land uses are organic farming of seasonal food crops, reducing cropping frequency and stall-feeding livestock during monsoon. National CAMPA funds can be utilized to initiate pilot projects where households who have adopted these practices are compensated for the foregone production cost. Such measures have resulted in a dramatic revival of little bustard population in Europe (Bretagnolle et al. 2011). To enable this course of community-based conservation, workshops have to be conducted in select villages within priority conservation areas. Effects of the above activities on bustard population and threat parameters need to be monitored so that policy-makers and managers can replicate the effective ones at larger scales. These activities have immense potential in sustaining green development and reducing our carbon footprint.

d) It has also been noted that general public have poor awareness of bustard and grassland conservation. Publicity materials such as posters, boards, and short movies need to be developed in collaboration with experts to raise general awareness of these issues.

Pilot implementations of surgical habitat management

a) Bustard breeding areas are public-private mixed ownership lands not entirely controlled by Forest Department, which makes it difficult to implement protective measures. There is a need to acquire revenue lands and some private lands to consolidate contiguous breeding areas and critical non-breeding areas. For instance, some small grassland patches within agricultural matrix might allow the birds to persist and needs to be protected from land use conversion in future. To facilitate this process, strategically located lands have to be identified and acquired by Forest Department utilizing State CAMPA funds. This activity can be viewed as compensatory land acquisition for industrial activities under the Forest (Conservation) Act, 1980. In some parks, rationalization of the boundary is also required in light of new information on species' distributions and persistent resentment or growing antagonism of local people.

b) Only 4-5 GIB breeding sites are left that are of critical importance to the species' survival, but do not contribute significantly to the persistence of other species. These sites need to be secured by legal status and total ban of consumptive human activities (excluding authorized management, protection, and research) during the breeding months: June-October. Enclosures that restrict livestock and nest predators need to be erected before the next breeding season. All mammalian predators (dogs, pigs, jackals, foxes, cats, and mongooses) need to be removed from these enclosures to reduce predation of GIB nests/chicks and improve recruitment. To restrict GIB inside enclosures during the vulnerable breeding phase, thereby minimizing human disturbances and improving recruitment rates, GIB food plants can be grown in enclosures.

c) Overhead power lines have to be routed underground or marked prominently to minimize the risk of fatal bird collisions (Silva et al. 2014) in priority conservation areas. Wind turbines should also be discouraged in these areas as they increase power-line networks and disturbances. Scientific dog sterilization, removal, and subsequent monitoring program have to be undertaken in priority conservation areas. This will benefit not only GIB but also other desert fauna since feral dogs are a major threat to all wildlife through the spread of diseases and predation.

4. Approaches and methodologies

The following activities will be undertaken by the Wildlife Institute of India in collaboration with its partner NGOs and State Forest Departments in research identified areas within bustard landscapes.

Activity 1: Conservation Breeding

A conservation breeding facility would be developed by the Wildlife Institute of India in consultation/collaboration with international bustard breeding agencies. The founder captive population would be formed from wild-collected and artificially incubated eggs rather than adult birds. Eggs have very low survival probability in the wild, whereas, capturing of wild birds can jeopardize the fate of in-situ populations. Set of favorable conditions (relatively higher rainfall, lower temperature and proximity to source population) has to be ensured to maximize the growth of the captive population. Keeping this in mind, a site near Mandvi (Kachchh, Gujarat) has been selected for developing the main center. Additionally, a satellite center has to be developed near Jaisalmer (Rajasthan) which is the most potential area for egg collection. The satellite center will have a small incubator, hatchery, and a chick holding facility, with uninterrupted water and electric supply. The role of satellite center would be to hold eggs until sufficient numbers have been collected at one go (5-8 per year) that would be transported by road in temperature-regulated containers to the main center. The main center would be developed with incubation rooms, hatcheries, juvenile and adult bird holding and breeding facilities, food processing facility, staff quarters and office, with uninterrupted electricity and water supply. The main and satellite centers would be constructed by the Civil Construction Unit of MoEFCC, with which WII has a Memorandum of Understanding. Centers would be constructed after appropriate planning with bustard breeding experts and zoo architects. The center will be run by professionals (center manager,

veterinary officer and technical assistants) who are appropriately trained in international bustard breeding facilities, with the guidance of visiting bustard breeding expert(s). Additional funds will be acquired to sponsor the international training trips of these officers. A detailed action plan will be developed in consultation with the visiting bustard breeding expert(s) in the first two years of the project. The facility will be run till a self-sustaining founder population has been established, which might take 25-30 years. Subsequently, captive-bred birds will be released into the restored habitats of Gujarat, Maharashtra, and Rajasthan, following scientific release protocols between 30-35 years. This project entails the first implementation phase of the conservation breeding program, and the budget including the contracts and salaries of the center staff will be revised at the end of this phase.

Activity 2: Applied research

The following research activities are essential to guide where, how and what in-situ management measures should be implemented for judicious investment of conservation funds.

2a) Population and habitat surveys

Existing and potential bustard habitats will be identified for conservation management and their status will be monitored for objective assessment of management effectiveness. The project proposes population and habitat status evaluation surveys for both endangered bustards inhabiting semiarid grasslands - the GIB and lesser florican. Two-phase surveys will be conducted by the research team in collaboration with Forest Department frontline staff to generate baseline information (2016-17) and detect changes (2020-21). These surveys will generate spatially explicit information on species' occupancy and abundance along with habitat status. A survey protocol based on line transect distance sampling and occupancy analysis (Buckland et al. 2004, Mackenzie et al. 2006) has been developed by Dutta et al. (2015) that can be further refined to achieve replication across other landscapes.

2b) Ranging patterns using biotelemetry

Landscape use patterns of bustards will be studied by satellite telemetry on 6-12 GIB (2-4 each in Rajasthan, Gujarat, and Maharashtra landscapes) and 4-8 lesser florican for 4-5 years. Birds will be captured using foot noose and fitted with 70gm (GIB) and 5 gm (lesser florican) solar GPS PTTs for transmitting location information to remote computers. This data can be analyzed with remotely sensed and field collected ecological variables (e.g., land cover, disturbance, topography, and food) to understand space use patterns. This activity will provide crucial information on seasonal movements, critical resources, relationships with human disturbances and connectivity between landscapes.

2c) Assessment of threats and livelihood concerns

For judicious utilization of conservation funds to mitigate threats at landscape-level, research teams will characterize the spatial distribution of power-lines, pesticide-prevalence and dog-densities. Spatial risk maps will be generated from the overlapping distribution of birds and these threats (see activity 3c).

For reconciling resource dependency of local communities and conservation goals, research teams will conduct sociological surveys to assess stakeholders' dependency on bustard habitats and their

perceptions regarding bustard conservation (Marshall et al. 2010). Agro-pastoral households will be sensitized on ecological hazards of inorganic farming and livestock overgrazing through mobile workshops and documentary films in collaboration with partner NGOs (see activity 4b-2). Subsequently, the willingness of agro-pastoralists to adopt bustard-friendly practices will be assessed based on choice experiments. Combinations of financial incentives like compensation, resource supplementation, relocation and alternate livelihoods will be provided for pursuing organic farming, reduced cropping, stall-feeding of livestock during monsoon or reduced stock size (Harihar et al. 2015). We will also include local communities' knowledge in land use planning through Participatory Rural Appraisals (Chambers 1994).

2d) Conservation genetics

Great Indian bustard and lesser florican feces and feathers will be collected systematically across each landscape during population/habitat surveys, dried, stored in plastic bags with silica crystals, and transported to WII laboratory at the earliest. DNA will be extracted from these samples using modified Qiagen tissue kit or Guanidinium thiocyanate method (Boom et al. 1990). DNA will be amplified using Polymerase Chain Reaction (PCR), with mitochondrial DNA markers and nuclear microsatellite markers, which have been used in other endangered bustard species. Individual-level data, thus generated, will be analyzed to a) estimate abundances of local populations in a spatial capture-recapture framework (Efford and Fewster 2013, Moore and Vigilant 2014); b) assess migration rates and patterns (differences between genders, landscapes etc.) between landscapes using a full likelihood and bayesian coalescence based computation analysis of genetic partitioning (Beerli and Felsenstein 1999, Hey and Nielsen 2007); c) estimate population parameters, including diversity statistics (Excoffier et al. 2005) and effective population size, using a likelihood analysis with Metropolis algorithm using random coalescence based method (Kunher 2006); d) determine phylogeographic structure using a bayesian phylogenetic analysis (Drummond and Rambaut 2007); e) identify geological and ecological processes influencing phylogeographic structure using coalescence based analysis in an approximate bayesian computation framework (Cornuet et al. 2008, Lopes et al. 2009, Wegmann et al. 2010, Lopes and Beaumont 2010); f) characterize population bottlenecks using tests of mutation-drift equilibrium with allele frequency data or coalescence based models (Piry et al. 1999, Cornuet et al. 2008); and g) compare genetic composition of captive stock with respect to the wild population based on genetic diversities (Excoffier et al. 2005) and population structures (Pritchard et al. 2000, Corander et al. 2008).

Activity 3: Capacity building and awareness

3a) Improving management enforcement

To enable real-time monitoring of illicit activities across vast GIB landscapes, a technology aided patrolling framework will be developed and implemented through frontline staff of Forest Department in conjunction with local people on the lines of MSTrIPES (Jhala et al. 2011). This activity entails developing tools (equipment, software and platform) that can be used by patrolling teams to collect information on ecological (species and habitat status) and management (poaching, land use conversion

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etc.) parameters. These information will be collated in a central database that will generate statistics and maps on spatial and temporal trends of these parameters to guide management decisions spontaneously. Research teams will train frontline staff of each state on the application of this tool during routine activities. This tool can also be used for assessing staff performance and providing incentives so as to improve protection enforcement. Attempts will be made to sensitize local youth on bustard conservation through our partner NGOs with the formation of clubs such as 'Friends of Bustard'. Sensitized people can be eventually engaged in patrolling activity through appropriate training by our research team on technology aided patrolling. Additionally, we will explore the possibility of supplementing enforcement with the use of Unmanned Aerial Vehicles. These 'Conservation Drones' are relatively inexpensive (~1 lakh INR), can fly across 25 km for 50 minutes while taking high-resolution aerial photographs that can be analyzed to map land-cover, monitor illicit activities and birds, and have immense potential in ecological monitoring (Koh and Wich 2012).

3b) Stakeholder sensitization

1) Research teams will identify key stakeholders of bustard landscapes and initiate informal meetings with them. Representatives from various stakeholder groups (decision-making and implementing officers in public/private agencies and local community members) will be invited to participate in workshops where they will be sensitized on bustard conservation issues. One 2-day workshops will be organized in each State, once every year, with the capacity of 10-20 participants. Workshops will be conducted by subject experts and local figures, and will include 'reality check' visits to bustard habitats.

2) To promote bustard-friendly practices in priority conservation areas, mobile workshops will be conducted in select villages by the research team and expert resource persons. These workshops would sensitize local land-users and encourage them to support bustard conservation (see activity 2c).

3c) Raising public awareness and support

To raise general awareness on bustard conservation issues, we will involve expert consultants for developing and distributing: a) publicity posters in educational and marketplaces in/adjoining bustard habitats; b) publicity boards in prominent places in/adjoining bustard habitats; and c) promotional documentary film on the need, challenges and efforts for bustard conservation featuring national and local celebrities (actors, sportsperson and spiritual gurus). The film will be uploaded on social network and aired in television channels for wider outreach and advocacy.

Activity 4: Pilot implementations of surgical habitat management

4a) Strategic land acquisition/rationalization

Areas intensively used by GIB for breeding and critical non-breeding activities will be identified through population surveys and radio-telemetry (see activity 2a-b). The ownership and extent of these lands will be mapped from Revenue and Forest Department documents and ground validation surveys. Critical lands owned by Revenue Department will be proposed for transfer to Forest Department. In case of private/community-owned lands, research teams will sensitize target land-owners about GIB

conservation and assess their willingness to sell lands. State Forest Departments will be encouraged to utilize State CAMPA funds for purchasing these private lands. A multi-criteria decision framework incorporating this information will be used to prioritize lands for acquisition by Forest Department. Relatively large and contiguous unprotected lands, which have high conservation value but pose practical problems against acquisition, will be proposed for declaration as Community/Conservation Reserves (Section 31A of Wildlife (Protection) Amendment Act 2002 (2003). In the process, some areas within Sanctuary expanses might be identified as poor wildlife habitat, and would be rationalized to alleviate local people from the legal restrictions on subsistence activities. These processes have already been initiated in Thar, Kachchh and Solapur landscapes by various agencies and need to be concluded.

4b) Breeding enclosure management

Priority GIB breeding enclosures (e.g., Sam-Sudasari, Ramdeora and Lala-Naliya) would be selected for experimental management with the paramount objective of improving bustard breeding success:

1) A predator- and livestock- proof chain-link fence (6 feet above ground, angled outside with barbed wires, and 1 feet below ground) would be laid around enclosures, each covering >10sqkm area. The required funds will be transferred to the Civil Construction Unit or to the respective State Forest Departments for undertaking these construction activities. Research teams would subsequently monitor the effectiveness of the fence in preventing undesired species from trespassing using signs/camera-traps.

2) Research teams would assess the status of nest predators (e.g., foxes, mongooses, monitor lizards, wild pigs and dogs) inside enclosures using camera-traps. The potential impact of these predators on ground-nesting birds would be assessed using dummy nests accessorized with camera-traps. On a need-basis, these predators would be trapped and released in suitable habitat outside the enclosure following scientific protocols and appropriate permits.

3) Food plants of GIB like alfalfa/lucerne *Medicago sativa* and chickpeas /gram *Cicer arietinum* will be cultivated organically in a few plots not exceeding a total of 1 ha area to increase food resources for birds. This activity of growing food crops will be restricted to one portion of the enclosure and completed before the onset of breeding season to minimize disturbance. Their effectiveness would be monitored by comparing bustard usage of these locations with that of random locations. If these practices yield favorable results, then State CAMPA funds can be utilized to replicate them elsewhere.

4c) Mitigating critical threats

1) To mitigate the detrimental effects of power-lines, research teams will map the spatial risk of bustard collision with power-lines by integrating information on electricity network (activity 2d), ranging patterns (activity 2b), and intensity of habitat use (activity 2a) following Silva et al. (2014). Based on the risk map, we will prioritize power-lines for the following actions: making overhead power lines underground in high-risk areas and marking power-lines with Bird Diverters in moderate-risk areas.

2) Abundance and ranging patterns of dogs will be assessed using mark-resight method and GPS data-loggers to map the spatial risk of wildlife encounter with dogs (Matthews et al. 2008). Large-scale scientific dog sterilization programme would be undertaken in priority areas by involving expert

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agencies like the Corbett Foundation and Human Society International. The effectiveness of this action would be monitored in terms of dog population trends in subsequent years.

3) Pesticide prevalence in bustard food and physiology will be assessed following Tanabe et al. (1998) from spatially representative samples of GIB and lesser florican fecal/feather and food samples. Areas where agricultural use of pesticides has to be reduced will be identified from a spatial risk map generated by overlapping the distribution of birds and pesticide prevalence. State Forest Departments and allied agencies (e.g., State Pollution Board and Agricultural Department) will be encouraged to provide financial incentives (Agro-environmental Incentive Schemes) to farmers for opting for organic farming in these priority areas. To demonstrate the pros and cons of such investment, National CAMPA funds will be utilized for pilot implementation of these agro-environmental incentive schemes in a small area of few square kilometers within the priority bustard habitat of each State.

5. Outcomes

- **Activities related to conservation breeding** will result in:

1. A functional breeding center in 5 years; and
2. A self-sustaining captive population of bustard as insurance against extinction in future.

- **Activities related to applied research** will result in:

1. A standardized protocol to monitor population/habitat status and assess management effectiveness;
2. Prioritization of conservation areas within bustard landscapes for land use planning;
3. Spatial risk maps of critical threats for judicious allocation of mitigation measures;
4. Understanding of livelihood concerns and scope of implementing bustard-friendly land uses to identify mechanisms that can balance conservation and livelihood needs; and
5. Comprehensive understanding of the past and present genetic scenarios of bustard populations and their causal processes to identify factors limiting species' recovery.

- **Activities related to capacity building and awareness will result in:**

1. Intensification of protection enforcement and spontaneous management of threats;
2. Sensitization of stakeholders (decision-makers and local people) about bustard conservation;
3. Community engagement in conservation; and
3. Increased public awareness and support for bustard conservation.

- **Activities related to pilot implementations of surgical habitat management** will aid in:

1. Identifying strategic lands for acquisition and revision of Protected Area expanse for effective conservation enforcements;
2. Demonstrating best practices for managing breeding enclosures; and
3. Mitigating critical threats in priority bustard habitats, such as reduction of dog numbers, overhead unmarked power lines and pesticide prevalence.

Log-frame

Goal	Action	Approach	Prerequisites / Assumptions	Output	Implementation time	Monitoring Indicators	Risks
Securing a captive population as insurance against extinction	Conservation breeding	Collection of wild eggs from Rajasthan; artificial incubation of eggs, rearing of chicks & adult birds to form a captive breeding population of GIB & (if needed) lesser florican in Gujarat	Mutual agreement & cooperation between partners (State Governments of Gujarat & Rajasthan & MoEFFCC); permits of egg collection & construction of breeding centers	Functional captive breeding facility	1-5 years	Laying & construction of basic facilities in 2 years	Obstacles in agreement & cooperation between partners, unavailability of wild eggs due to poor rainfall & other stochastic events that can reduce production in captivity
						Initiation of artificial incubation on 3rd year	
						Addition of birds in captivity from artificially incubated eggs on 5th year	
				Development of captive breeding population	10-25 years *	Initiation of reproduction in captivity on 15th year	
					25-30 years *	Formation of founder population in captivity on 30th year	
				Reintroduction of captive birds	30-35 years *	Initiation of site selection & reintroduction	
Recovery of wild population & improvement of habitats	Applied research	Satellite telemetry	Permits related to tagging of birds & import/use of telemetry equipment	Prioritization of conservation areas	1-5 years	Tagging of 3 GIB by 2nd year & 6 GIB by 3rd year	Delay in permits & loss of tags
						Satellite data acquisition of >1 year by 4th year	
						Report on spatial prioritization on 5th year	
		Population/habitat surveys - line transect & habitat plots	Research permits, cooperation & infrastructure of State Forest Department	Baseline estimates of population & habitat status	1-5 years	Status survey reports on 2nd year	Inadequate statistical power to detect population trends due to rarity of birds
				Preliminary assessment of management effectiveness	1-5 years	Status survey report on 5th year	
		Characterization of threats to guide threat mitigation	Coarse-scale understanding of bustard occupied areas	Threat maps (power-lines, pesticides & dogs)	1-5 years	Threat assessment report on 5th year	Future shifts in distribution of threats
		Social surveys & appraisals	Coarse-scale understanding of bustard occupied areas	Understanding of local communities' resource dependency, conservation attitude & willingness to adopt sustainable landuses	2-4 years	Social survey reports on 4th year	
	Pilot surgical habitat management	Breeding enclosure management (fencing, predator-removal & food provision)	Cooperation & facilitation of management actions by Forest Department	Demonstration of best-practices for managing breeding enclosures	1-3 years	Improved recruitment rate of birds based on dummy nest experiments on 3rd year	Lapse in motivation & non-sustenance of practices beyond project period
		Mitigating critical threats in priority areas	Fine-scale information on priority bustard habitats & cooperation of relevant agencies	Marking of power-lines & population control of dogs in priority bustard habitats	1-5 years	Reduction of threats in priority bustard habitats based on reports before (2nd year) & after (5th year) the implementation	Lack of support from power corporations & local people
		Surveys to identify lands for strategic acquisition & rationalization	Fine-scale information on priority bustard habitats	Revision of Protected Area expanse to improve management & reduce antagonism	2-4 years	Report on land identification for acquisition/rationalization on 4th year	Lapse in Government will & inadequate funds to acquire lands
Stakeholder engagement in	Capacity-building &	Implementation of technology aided	Logistic support & facilitation of Forest	Regular & systematic collation of ecological/	1-3 years	Patrolling information database & reduced time-lag in management interventions on 3rd year	Lapse in motivation & non-sustenance of

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Goal	Action	Approach	Prerequisites/ Assumptions	Outputs	Implementation Time	Monitoring Indicators & Time	Risks
conservation	awareness	patrolling through technology & incentives	Department for implementing program	management information to guide management			activity beyond project period
		Workshops to train forest officers	Formulation of coursework & publication materials in collaboration with experts	Improvement of management skills	1-5 years	Officer training assessment reports every year	Non-cooperation of Forest Departments
		Workshops to sensitize non-forest officers		Sensitization of decision-makers & to plan landuses as if conservation matters	1-5 years	Positive conservation attitude of officers based on feedback reports every year	Non-cooperation of other departments & agencies
		Mobile workshops to sensitize local people		This activity will promote conservation support & sustainable landuses	1-5 years	Positive change in conservation attitude of local communities based on social surveys before (2nd year) & after (5th year) workshops	
		Production & distribution of publicity materials		Public awareness about bustards & their conservation significance	2-4 years	Positive change in knowledge about bustards based on social surveys before (2nd year) & after (4th year) publicity campaigns	
	Promoting bustard-friendly landuses	Pilot implementation of compensation schemes to incentivize bustard-friendly landuses in priority conservation areas	Fine-scale information on priority bustard habitats	Increased crop-area under organic farming & reduction in livestock grazing during breeding season in pilot implementation areas	3-5 years	Reduction in pesticide usage & increase in herbaceous cover in implementation areas on 5th year	Lapse in liaising & funding support for replicating this activity beyond project period & other priority areas

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Budget (Amount in Lakhs INR)

Head	Particulars	Yr 1	Yr 2	Yr 3	Yr 4	Yr 5	Total
Staff engagement	3 Project Scientists (1 CBC + 1 vet + 1 field)	20.16	22.18	24.39	26.83	29.52	123.08
	2 Project Associates (field)	10.85	11.93	13.13	14.44	15.88	66.23
	4 Project Assistant grade 2 (2 CBC + 2 field)	9.60	10.56	11.62	12.78	14.06	58.61
	4 Project Assistant grade 1 (1 CBC + 3 field)	7.30	8.03	8.83	9.71	10.68	44.54
	8 Field assistant grade 2 (5 CBC + 3 field)	10.08	11.09	12.20	13.42	14.76	61.54
	3 Field assistant grade 1 (field)	2.88	3.17	3.48	3.83	4.22	17.58
	Daily labour in field & CBC	3.06	3.37	3.70	4.07	4.48	18.68
	Project Management Unit (part cost)	15.36	13.65	14.80	16.05	17.43	77.29
	Total costs of staff engagement	79.28	83.96	92.15	101.14	111.02	467.55
Conservation Breeding	Center establishment costs	414.00	270.00	225.00	90.00	90.00	1089.00
	Center running costs	14.85	39.85	41.84	41.84	43.84	182.22
	Center maintenance costs	0.00	0.00	4.50	22.50	22.50	49.50
	Miscellaneous costs (training, collaboration & contingency)	47.44	36.49	18.82	15.07	15.52	133.34
	Total costs of conservation breeding	476.29	346.34	290.16	169.41	171.85	1454.06
Applied research	Satellite telemetry costs (PTT & trapping costs)	33.34	52.09	16.05	14.85	15.53	131.86
	Threat assessment surveys (vehicle charges)	13.50	13.50	14.85	14.85	15.53	72.23
	Population/habitat surveys (honorarium, vehicle, accommodation & tools – GPS & binocs)	18.43	3.00	0.00	0.00	24.64	46.06
	Surveys for land acquistion/rationalization, social aspects & other species status	0.00	5.40	5.94	5.94	0.00	17.28
	General field equipment (camera traps, laptops, cameras, accessories & stationary)	17.70	2.07	2.28	2.28	2.38	26.70
	Accommodation & travel	7.92	7.92	8.53	8.72	9.14	42.23
	Research/conservation laboratory (genetics & pesticides): equipment (part cost) & analysis charges	58.35	13.35	14.69	14.69	34.82	135.89
	Contingency (collaborative service charges & miscellaneous)	10.46	7.87	6.42	6.37	8.55	39.66
	Total costs of applied research	159.70	105.20	68.75	67.69	110.58	511.92
Capacity-building & awareness	Training of Forest/Conservation Staff (wildlife specialization & other trainings)	0.00	20.00	21.00	21.00	23.00	85.00
	Technology aided patrolling (developing tools, conducting training workshops for implementation & equipments)	13.14	17.14	13.35	4.40	4.60	52.63
	Workshops to sensitize non-forest officers (materials, travel & accommodation) – 3 workshops/yr & 15 participants/workshop	8.94	8.94	9.83	9.83	10.28	47.83
	Mobile workshops to sensitize local people (equipment, materials, travel & logistics) – 15 villages/yr & ~500 people/yr	4.00	3.60	3.96	3.96	4.14	19.66
	Awareness materials (posters, boards & documentary film)	0.40	7.40	8.14	2.20	0.00	18.14
	Contingency (collaborative services & miscellaneous)	6.32	7.85	8.31	7.57	7.85	37.91
	Total costs of capacity-building & awareness	32.80	64.93	64.60	48.96	49.87	261.18
Pilot habitat management	Predator-proof-fencing in critical enclosures	108.00	144.00	0.00	0.00	0.00	252.00
	Predator population management (traps, drugs, darting guns & neutering costs)	43.00	24.00	24.00	4.00	0.00	95.00
	Marking power-lines with Bird Diverters	91.00	0.00	0.00	68.25	68.25	227.50
	Agro-environmental Incentives & food provisioning in enclosures	5.00	5.00	53.00	53.00	0.00	116.00
	Total costs of pilot implementation of habitat management	247.00	173.00	77.00	125.25	68.25	690.50
	TOTAL	995.08	773.44	592.66	512.45	511.57	3385.20

CBC = Conservation Breeding Center

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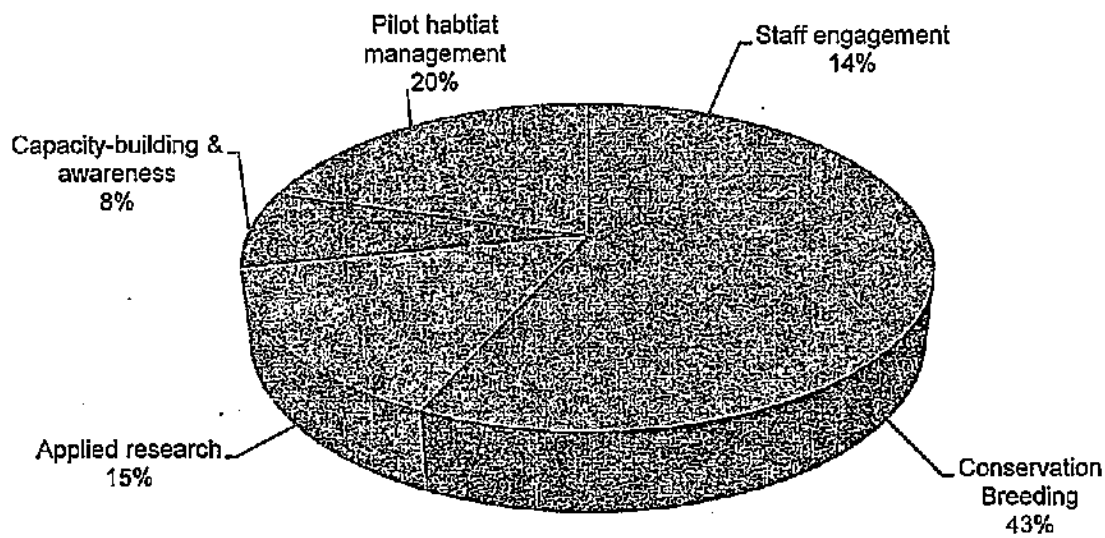
Summary table (Amount in Lakhs INR)

Head	Year 1	Year 2	Year 3	Year 4	Year 5	Total
Staff engagement	79.28	83.96	92.15	101.14	111.02	467.55
Conservation Breeding	476.29	346.34	290.16	169.41	171.85	1454.06
Applied research	159.70	105.20	68.75	67.69	110.58	511.92
Capacity-building & awareness	32.80	64.93	64.60	48.96	49.87	261.18
Pilot habitat management	247.00	173.00	77.00	125.25	68.25	690.50
Total	995.08	773.44	592.66	512.45	511.57	3385.20

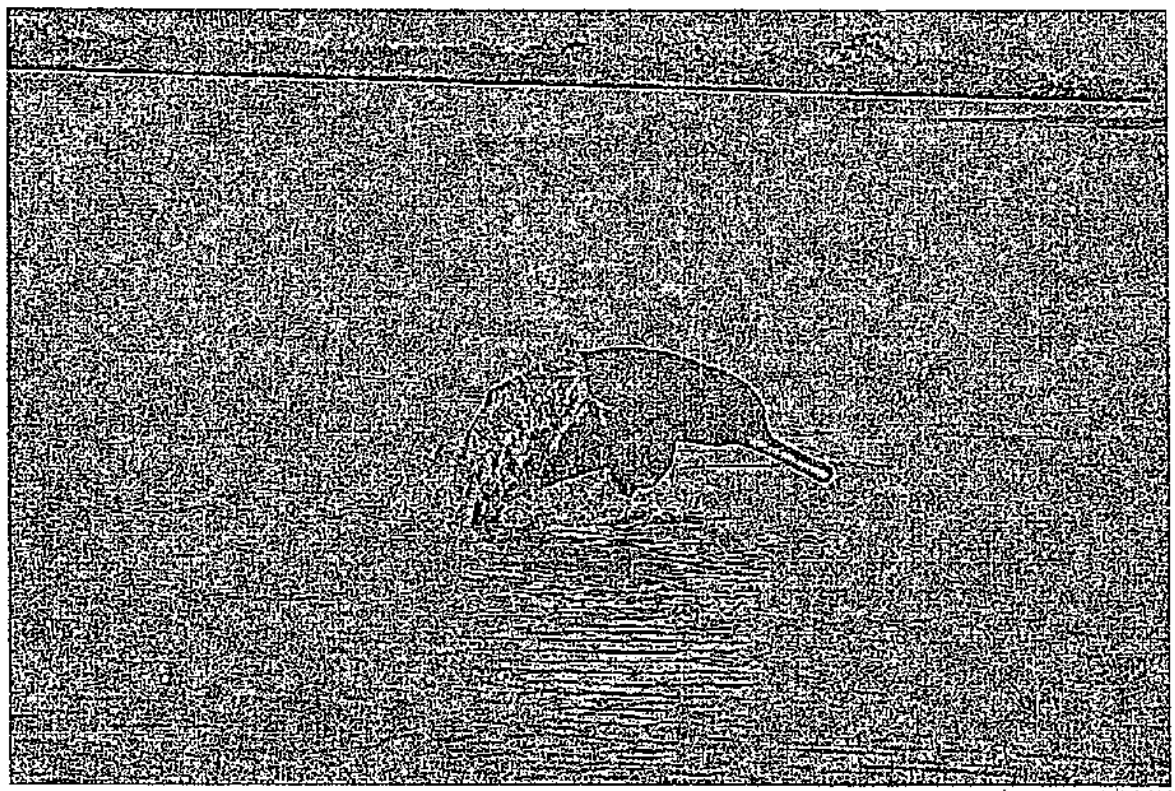
Pie-chart showing budget-allocation for various project activities



** 32% of the budget (Rs. 1089 lakhs) has been allocated for establishing the Conservation Breeding Centers – main & satellite facilities. The estimated costs include: (a) construction of a predator-proof enclosures around 4.5 km^2 area that have been sanctioned for the centers (12 km perimeter) @ Rs. 1,200,000/km = Rs. 144 lakhs; (b) construction of buildings (office, staff quarters, store & egg/food/chick chambers) with furniture in 600 m^2 space @ Rs. 50,000/m^2 = Rs. 300 lakhs; (c) construction of pens (separate for juvenile, adult & quarantine birds) in 9000 m^2 area @ Rs. 2500/m^2 = Rs. 225 lakhs; (d) breeding facilities (infrastructure, equipment, electrical/electronic appliances etc.) at two centers @ Rs. 120 lakhs; (e) uninterrupted water, security, power facilities at two centers @ Rs. 120 lakhs; and (f) modification costs of enclosures, buildings, facilities & infrastructure to accommodate more birds & unforeseen situations @ Rs. 180 lakhs.

Annexure-II

Development of Conservation Action Plan for River dolphins *(Platanista gangetica gangetica)*



A.Wakid

Implementing Agency	:	**Wildlife Institute of India**
Project Partners	:	**State Forest Departments of Bihar, Uttar Pradesh, Assam, West Bengal, Madhya Pradesh, ARANYAK,WWF, Patna University, Bhagalpur University and Indra Prastha Institute of Information Technology (Delhi)**
Project Cost	:	**23.0 Crore**
Project Duration	:	**2015 – 2020**

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PROJECT BACKGROUND

India's National Aquatic Animal, Gangetic dolphin (*Platanista gangetica gangetica*), is restricted to the Ganges-Brahmaputra-Meghna and Karnaphuli river systems of India, Nepal and Bangladesh (Jones, 1982; Sinha, 1997). Ganges dolphin is locally known as *Susu* in North India and *Hihu* in Assam. IUCN listed the Gangetic dolphin as Endangered in 2004 as its population has declined by more than 50%, and the decline is expected to continue. In 2008, the dolphin was declared as the State aquatic animal of Assam and in 2009 as National aquatic animal. The Gangetic dolphin now receives the highest level of protection available in India as a Schedule-I Species listed under the Wildlife Protection Act 1972.

Smith et al (2011) estimated the minimum population of Gangetic dolphin as 1200-1800. In Bangladesh, Ganges dolphins occur in Jamuna River, Kushiyara River, Burhi-Ganga. Karnaphuli–Sangu River system and in Sundarbans (Fig1). In Nepal, it occurs in Karnali River (from Kachali to Kotiaghat), Saptakoshi river (confluence of Arun and Sun Koshi to Kosi Barrage), Narayani river (Devghat to Triveni Barrage (Fig 1). In India it occurs in Ganga (Bijnour to Farrkka) and its tributaries like Yamuna (from Hamirpur down stream), Ken (from confluence of Yamuna at Chilla to Sindhan Kala village) , Betwa (from confluence of the Yamuna to Orai), Sind, Kosi (Kosi Barrage to Kursela), Gandak, Gerua (from India- Nepal border to Girijapuri Barrage), Sharda, Son and in Brahmaputra river (Assam-Arunachal border to India-Bangladesh border) and its tributraries such as Kulsi and Subansiri (Fig 1) (??Smith et al 2011,Wakid et al 2012).

There is a drastic decrease in the distribution range of the species within last few decades. In Ganges, the species distribution range was declined by about 100 kms since late 1800 (Smith et al, 2004). In Yamuna River, the species was distributed upto Delhi (Anderson, 1879), but now the distribution is restricted much more downstream. Like-wise, once occurring in reservoir behind the Kaptai dam of the Karnaphuli-Sangu system (Ahmed 2000), the species is now completely declined from there. In Brahmaputra river system within India also, the population distribution range has been declining very rapidly within last 5 decades, especially from the tributaries of Brahmaputra River (Wakid, 2009). Anthropogenic disturbances are the main cause of this dramatic population decline. Water development projects, especially dams and barrages, pollution, deliberate killing for oil, accidental killing through fishing nets are the major man-made causes of the population decline. Several key categories of potential threat are: (a) fragmentation of the dolphin habitat, (b) reduction or elimination of habitat simply in terms of dry-season flow, (c) "escapement" of dolphins into canals where they are unlikely to be able to get back into rivers and are therefore

doomed, (d) cascading effects from interrupted migrations of prey organisms, degradation of prey spawning habitat and overharvesting of fish (e) contaminant flux leading to significant changes in chronic and/or acute exposure to toxins, (f) loss of complexity (channelization, sediment entrapment), (g) making the rivers less habitable for dolphins due to mining and developmental works, and (g) agricultural runoffs of fertilizers and pesticides.

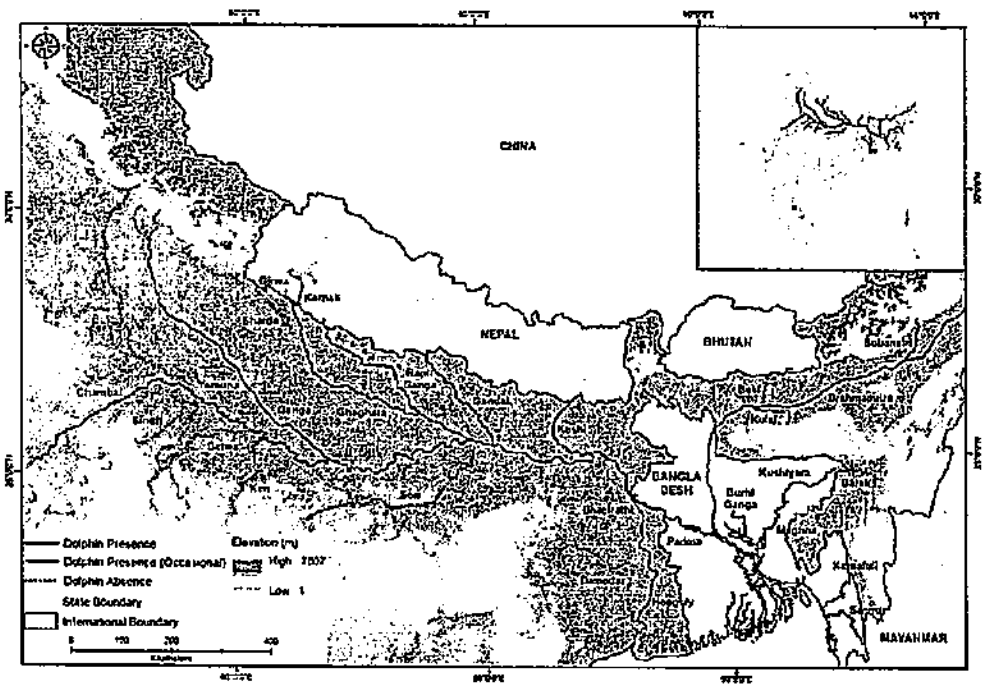

Fig 1: Distribution of Gangetic dolphin in Ganga, Brahmaputra and Karnaphuli-sangu river systems.

The Ganges river dolphin is almost blind and can live in freshwater with small population living in low salinity estuarine areas. They emit ultrasonic sounds to prey on fish and detect other objects under water. They are solitary seldom found in small groups, generally a mother and calf seen together. Females are larger than males and give birth once every two to three years to only one calf. Ganges dolphin reproduces at the age of 6–10 years and maximum longevity may be close to 30 years (Sinha 1997). Ganges River dolphins are generally concentrated in counter-current pools below channel convergences and sharp meanders and above and below mid-channel islands, bridge pilings, and other engineering structures that cause scouring (Sinha 1997,Smith 2011 Wakid 2012). Their fidelity to counter-current pools is probably greatest in fast flowing channels. Annual monsoon floods cause great variability in the dolphins' access to large parts of their range. Isolation in seasonal lakes sometimes occurs, as does "escapement" from the river channels into artificial water bodies such as canals and

reservoirs. Ganges River dolphins are not generally known to occur in salinities greater than 10 ppt, although they have been recorded in waters as saline as 23 ppt.

Little is known about its ranging pattern, behaviour and resource utilization due to difficulties in underwater studies. With recent technological advances in underwater photography, sound recording and several other sensors available to assist in collection of important ecological information, it will be easier to address the paucity of information.

GOAL AND OBJECTIVES

Dolphin is indicator of river quality, not only for river ecosystem integrity but also for sustenance of humans. To keep our river system healthy we need to conserve dolphins and monitor it as indicator of river health. Therefore, this program aims to develop recovery plan for the Gangetic dolphin populations and their habitats in India. This program also aims to develop Ganga and Brahmaputra river monitoring system with dolphin as flagship species. The program will also engage people dependent on river specifically fisher folk, and other water dependent profession and industries.

The project has following aims:

1) Recovery plan of Gangetic dolphins and their habitats in India.
2) Engagement of stakeholders in conservation of River Ecosystems in India.

The main objective of this projects are :

1) To develop monitoring protocol for dolphins.

2) Status of associated river fauna like Gharial, Otter, Tutrtles and Fishes.

3) Quality assessment of river habitat in terms of water quality, anthropogenic pressure and landscape surrounding riverscape.

4) Evaluate the current status of invasive species in riversacpe.

5) Involve stake holders to develop a network which will assist in dolphin conservation.

The project envisage to fill in the gaps of current knowledge about ecology of dolphin and riverscape. Stake holders will involve fishermen, agriculturists and industry dependent on river system for their sustenance and objective of the study is how their practices can be made least destructive for riverscape conservation.

SCOPE OF WORK

The main aim of the plan is the recovery of the declining Gangetic dolphin populations and improving its habitat. Under this broad aim the plan has following specific actions.

Research

- Status Survey and long term monitoring of Gangetic dolphin, associated river fauna and their habitat in India using advanced technique.
- Identification and mapping of threats and critical habitat of Gangetic dolphin in India.
- Ecology of Gangetic dolphin in India.
- Genetic study to identify meta-population structure and genetic diversity.
- Develop protocol and procedure for dolphin rescue and rehabilitation.

Conservation Action

- Develop awareness for conservation of Gangetic dolphin and its habitat.
- Promoting participatory management of Gangetic dolphin and their habitats by mainstreaming the dolphin conservation into production sectors such as Hydro-electric projects, Oil sector, Fisheries, Irrigation etc.
- Reduce direct and indirect causes of Gangetic dolphin mortality.
- Identify, conserve, manage and restore critical habitats of Gangetic dolphin habitats in India.
- Develop rescue centre for temporary holding for dolphins.

Capacity Building

- Enhance capacity of concerned stakeholders in participatory management of dolphins and their habitats.
- Enhance capacity of concerned stakeholders towards use of advance technology in monitoring and management of dolphins and their habitats. Develop capability in rescue, rehabilitation and disease investigation

APROACH AND METHODOLOGIES

Research

Status Survey and long term monitoring: A comprehensive review of the dolphin survey methods that were followed by earlier studies (Mohan et al., 1997; Biswas & Baruah 2000; Smith & Reeves 2000; Wakid 2009; Braulik 2006, Wakid & Braulik 2009; Baruah et al. 2012, Vidal 1997; Smith et al 2006; Dawson et al 2008; Zhao et al 2008) were reviewed extensively and Wakid et al (2012) survey method was found to be suitable for dolphin survey. This method involve Mark- recapture based line transect survey in conjunction with use of hydrophones based detections. In areas where large

boats can be used, two decks were used for two observer teams to do independent observation. In places where water will be shallow, two flat bottom or country boats in tandem will be used as two observers for survey. Regarding group size, except for mother- young pairs, the motivation for individual Ganges river dolphins to form "group" appears to be the common use of habitat, defined by hydrology and geomorphic features, rather than obvious social affiliations (Smith 1993, Smith *et al.* 1998, 2001). During the survey, group was defined as individuals seen with close proximity of each other.

In conjunction with the boat based visual survey of dolphins, we also conduct acoustic survey of dolphin to reduce the sighting bias in visual survey which may occur due to the dolphin behaviour. The acoustic survey was conducted using hydrophones (A_tags). Two stereo acoustic data loggers will be towed behind the boat to detect dolphins.

The other important fauna like gharial, turtles, otters and fishes will be monitored using, line transect, mark-resight, and catch per unit effort (Talwar and Jhingran 1991, Waklid, 2012). The habitat quality will be recorded at every km and at each sighting of species of interest.

Monitoring for entire stretch of Ganga and Brahmaputra will be done on annual or biannual basis, with important stretches being monitored on annual basis. The monitoring will be done by concerned forest department with assistance from local Institution (Institute, University or NGO/NGI)

Monitoring and mapping of habitat and threats: The anthropogenic activity like use of banks for human activities, fisherman, type of fishing activity, waste disposal by people and industrial waste disposal points will be recorded. Water samples will be collected at every 1 or 5 km depending on intensity of use of sector by people or industry for water quality and pollutant monitoring. Fish and sediments will also be collected at regular interval for pollutant monitoring.

Water depth, current and width of river at sampling point will be recorded. For water quality analysis YSI handhold professional multi-parameter equipment will be used and samples will also preserved for detail laboratory monitoring. The water quality equipment will be set up to automatically log water quality data at 1 km interval. Following parameters were recorded by this equipment; Temperature (in ^{0}C), pH , dissolved oxygen (in % L and mg/L), total dissolved solid (in mg/l), salinity (in ppt) and Pressure (in mmHg). Along with the above-mentioned water quality parameters, we also analyse turbidity (by Turbidity Meter), Ammonia (by YSI photometer), Nitrate

(by YSI photometer), Nitrite (by YSI photometer) and Phosphate (by YSI photometer). The preserved water samples and tissue samples from fish and dolphin (from dead dolphins) will be analysed for pollutants specifically pesticides, heavy metals and other harmful chemicals which may affect reproduction in dolphins.

The Ganga and Brahmaputra river system will be mapped and change of river character for dolphin and associated fauna will be assessed. We will map the river and surrounding 2 km area for change in geomorphology and land use using supervised and unsupervised classification (Jenson 1996). We will use MODIS, AWiFS, Landsat, IRS, and Quickbird digital satellite data for mapping.

Ecology of dolphin: Little is known about feeding ecology, habitat use and demography of this species due to nature of habitat. We will study the habitat use and resource utilization on trial basis at select high density area using under water vehicle (with remote cameras and sensors), fish finders, underwater camera traps and radio telemetry. If the experiment will provide meaningful data we will extend this in areas important for dolphin conservation. We will also address the resource partitioning between dolphin and other aquatic predators like gharial, otters and crocodiles.

Genetic study is needed to understand the existing spatially structured genetic diversity, the presence of population bottlenecks, population demography and the female effective population size. The tissue samples will be collected from carcass as well as those available with different organizations. All samples will be preserved in 70% ethanol and stored at –20°C for subsequent analysis. We will use polymerase chain reaction (PCR) to amplify mitochondrial (mtDNA) sequences of the control region and cytochromeb (Dalebout et al. 1998). PCR products will be purified using QIAquick PCR purification kit (Qiagen). Nuclear DNA will be amplified using microsatellite markers be selected on the basis of previous cetacean studies (Hamilton et al 2001, Oremus et al 2007). To understand the genetic diversity and female effective population size, the mtDNA sequences will be aligned and assembled using SEQUENCHER v. 4.6 (GeneCodes, Ann Arbor,Michigan). Estimation of genetic diversity and other population parameters like measures of nucleotide diversity (p), haplotype diversity (h), Tajima's neutrality test (Tajima 1989), and mismatch distribution testing for demographic expansion, equilibrium or bottleneck (Rogers and Harpending 1992), will be computed using the program DnaSP v. 5.10 (Librado and Rozas 2009). We will determine the degree of genetic structuring by examining an unrooted phylogenetic network described by Bandelt et al. (1999), using the software NETWORK v. 4.5.1 (http:// www. fluxusengineering. com). We will estimate effective female population size using LAMARC v. 2.1.3 (Beerli and Felsenstein 1999, Kuhner 2006, Ishtiaq et al 2011). Presence of a population bottleneck can be determined using a coalescence based method implemented in BOTTLENECK v.1.2.02 (Luikart & Cornuet 1998). Spatial

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genetic structuring will be examined by using STRUCTURE v. 2.3.4 (Pritchard et al 2000) with nuclear microsatellites and BAPS V2 (Corander et al 2004) with mtDNA. The sex of sampled dolphins will be identified by amplification of a fragment of the *sry* gene multiplexed with fragments of the ZFY/ZFX genes as positive control, and as described by Gilson et al. (1998).

Dolphin rescue, rehabilitation and disease monitoring: There were several incidences of dolphins getting isolated or injured. There is urgent need to develop appropriate protocol for keeping and nursing these dolphins till rehabilitation is done. Program will also develop protocol for transportation of dolphin. The Caracas will be assessed for disease as well as sampling will be done for potential disease causing organism known to affect dolphins.

CONSERVATION ACTION

Conservation awareness and participatory management: Awarenes amongst various stake holders and their involvement and conserving dolphin is most important. Dolphins are threatened by poaching, accidental bycatch and pollution of their habitat. We plan to develop "Dolphin Sanrakshaks" and "Dolphin Conservation Network". This will be done by engaging fishing community by employing fisherman as well as honorary positions along rivers. These individuals will be the nodal points in a community to create local network. The network will collect data about dolphins and other variables of interest in simple formats. For data collection, transmission and contact we will use mobile telephone network. We will also engage other stake holders (Industry- small and large) through the same model of "Conservation Network" (Shah et al 2010,Wakid 2012). We will engage media specifically radio to spread the message of dolphin conservation (Shah et al 2010). Schools and colleges in riverscape will be engaged in conservation program. The conservation awareness work will involve short films on dolphins, radio spots, Television programmes and traditional communication like theatre. We will prepare booklets and educational material for school and colleges to promote dolphin and river conservation issues.

Reduction in cause of mortality: One of the main reasons for poaching is dolphin oil which is largely used for fishing. There is urgent need to gather information about extent of this practice. Through afore mentioned awareness campaign we will try to convince people as well as provide alternative to replace dolphin oil by other substitute. There are lot of cases of accidental deaths of dolphins due to entanglement in fishing nets. We will experiment with the use of net aversion devices like pingers (sound device) and reflectors. The efficacy in terms of habituation and effectiveness will be tested in select areas. Once the efficacy and design will be standardized pingers and

reflectors will be promoted amongst fishermen and taken up with Fisheries department to ensure its use with Central and State Government's financial assistance. Dolphin conservation network will be used for information gathering for dolphin entanglement, poaching. The entanglement information will be relayed to nearest rescue centre and expert team for prompt action. Poaching information will be relayed to nearest forest chowki for action.

River habitat conservation: The major challenge in conserving river system is not only to save the integrity of riverine ecosystem but secure people's dependence. The issues are pollution from industry and human waste water disposal, agricultural intensification along river banks with increase in use of fertilizers and pesticides. These are complex issues and need policy interventions and awareness program. The effluents and pollutants from industry need to be managed by effluent treatment plant. This work is undertaken under Ganga cleaning action, the project will only collect relevant information affecting fauna and its impact across the river system to help develop appropriate mitigation strategy. Sand mining and its effect on river health need to be assessed, to develop comprehensive plan how to deal with this problem. Policy for water drawls and dams are important, to ensure ecological flow as well as provide connectivity between isolated populations.

Rescue centre: Temporary rescue centre at river fronts are needed in each state to rescue and rehabilitate dolphins which are injured during fishing activity or stranded during flood. Veterinary care unit in each state will develop a unit which will address any issue of veterinary emergency related to dolphin or other aquatic species. Plan and model will be developed to create temporary rescue units locally at time of need and appropriate transportation protocols. The dolphin conservation unit linked with mobile network will assist in providing information and assistance in rescue. This unit will also keep watch on disease and pollutant related incidents.

Capacity Building: The capacity building will be done for three major groups, scientist and researchers of WII and partner Institution, State Forest Department, Fisheries Department, Animal Husbandry Department and Fishermen.

1) Monitoring: State forest department personnel will be trained in scientific monitoring of dolphins and river system. The forest department personnel will be trained in two phases –
    i) The select Forest officer in-charge of Divison/Range having Ganga and Brahmaputra flowing through their Division will be trained and they in turn will train other staff members.

ii) During survey the Forest Department teams will be trained in scientific monitoring. After completion of first survey and data analysis the process will be shared with each state. It is envisaged that from second survey onward the monitoring process will be done by states with assistance from WII and other partner agencies.

iii) Training will be done for fishermen network to monitor dolphins.

iv) School and college students will be trained in volunteer program for monitoring.

2) Scientist and Researchers of WII and Partner Institution will also get trained by National and International experts on various research protocols needed to monitor river health. Video conferencing and visits of National and International experts is visualized in this component.

3) Veterinarian from WII, State Forest Department, Animal husbandry units and Partner agencies will be trained in rescue, handling and data collection protocols related to Post mortem and sample collection. Rescue and Disease monitoring training in aquatic system will be done by National and International experts through video conferencing and expert visits.

4) Workshops for training and evaluation of project outcomes on annual basis as well as need based.

EXPECTED PROJECT OUTPUT

The action plan proposes following major outcomes;

- Standardized techniques for State Forest Department and Community based monitoring system for dolphins and their habitats.
- Recovery of dolphin populations due to reduction in mortality caused by accidental catch and poaching.
- Improved understanding of dolphin populations and their habitats.
- Awareness for conservation of dolphin and its habitat among various stakeholders.
- Develop a blue print for participatory management of dolphins and their habitats involving all concerned stakeholders including hydro-electric projects, irrigation, agriculture, oil sector and fisheries.
- Changes in fishery policy for control of invasive fish introduction and dolphin conservation.

- Identification of stretches of rivers crucial for dolphin and associated fauna conservation for community reserve. The community reserve will enhance the income of river dependent people through targeted investment by various Government departments.

- Strengthening the 'Clean Ganga' programme of the Government of India.

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Logframe for Dolphin Conservation Action Plan

Goal	Activity	Inputs	Assumption	Implimentation Time Frame	Output	Verifiable Indicators and Time	Risks
1) Increase in Abundance of Dolphins and associated fauna	1)Dolphin and associated species monitoring	Population estimation: Mark Recapture based estimates , Line transect , Under water detection using hydrophones	Infrastructure and support of Forest Deptt	Initial 2 years to complete entire range after that survey in a season will be conducted by States	Population Estimates	Scientifically acceptable abundance estimate in 2 years time, after that annual estimate in crucial areas and biannual in entire stretch.	Law and order problem in certain river stretches. Sustenance of activity on long term basis ie beyond project life
		Training of Forest Deptt staff	Acceptance and Willingness to impliment	Initial 2 years after this period only hand holding by associated agencies.	Timely and scientifically reliable results	Increased skill level in 2 years time	Loss of institutional interest and sustenance of activity
		Awareness and Training of Fishermen for Dolphin Monitoring	Fishermen will be willing and perceive benefit. Forest Deptt and Associated agencies like Fisheries Deptt. will participate	Will be actively involved after 1 or 2 years of network creation	Co-operation in conservation	Increasing trend in reporting of dolphin bycatch and poaching. Will take 2 to 3 years for full functionality	Unwillingness due to perception of threat to their livelihood. Lack of long term sustenance
	2)Decline in accidental catch of dolphins	Use of pingers and reflectors by fishermen	Willingness to use pingers and reflectors	After 2 years of experimentation, plan will be implemented in crucial dolphin areas	Decline in accidental catch and poaching incidence	Decline in reporting of accidental catch by fishermen network and monitoring sites	Lack of Co-operation and long term sustenance and replacement of equipments

Goal	Activity	Inputs	Assumption	Implimentation Time Frame	Output	Verifiable Indicators and Time	Risks
	3)Dolphin rescue and rehabilitation	Veterinary setup and temporary rescue centre at river fronts	State Forest Deptt. will provide infrastructure	Full functionality after 1 to 2 year of experimentation and learning	Decline in mortality of stranded and injured dolphins	Increase in survivorship of rescued dolphins	Lack of infrastructure and long term sustenance of rescue centre
	4)Use of alternative for dolphin oil	Create awareness and provide alternative for dolphin oil.	Will able to produce alternative which is good and acceptable	2-3 years for implementation	Decline in poaching reports	Increase in use of alternative. The alternative is as good as dolphin oil as cat fish lures.	Efficacy of alternate not as good as dolphin oil. Acceptability of alternative and its promotion by Forest and Fisheries Deptts.
	5) Habitat Mapping	Remote sensing data, Secondary data regarding flow, fish landings, development	Secondary data will be reliable and available over different time frame	2 years, Detail time series data in 3 - 4 years	Habitat map with critical conservation area and threat mapping	Land use map with information regarding riverscape quality and conservation value	Lack of good quality time series data from different agencies working in this area
	6) Genetic study	Samples across its range and lab analysis	Large sample size will be available	3-4 years	Level of genetic diversity and spatial nature of population will help in taking appropriate mitigation measures	Information on genetic diversity and level of isolation among different river stretches	low sample size
	7) Fish Abundance	Sampling of fish at different locations. Fish landing site statistics.	Fish landing site information from historical time will be available.	2-3 years	Fish abundance index	Data about fish productivity from different reliable sources	low sample size and lack of historical data

Goal	Activity	Inputs	Assumption	Implimentation Time Frame	Output	Verifiable Indicators and Time	Risks
2) Improvement of riverine habitat	2) Monitoring of habitat quality	Collect data for deleterious anthropogenic activity, fertilizers, pollutant load, water quality	The Ganga action plan will improve the riverine habitat quality and information generated through this project will be used in targeted action	1-2 years for water quality monitoring	Habitat quality indicators	Positive change in water quality parameters	Delay or failure of large scale implementation of Ganga cleaning program.
3) Protection of riverine habitat	1; Creation of Community and Conservation Reserves	Research inputs will identify important areas for dolphin and associated fauna. Government schemes to improve livelihood options	Local people, Fisheries Deptt and Forest Deptt will be willing to having participatory management	3-5 years	Creation of Community and Conservation Reserves	Creation of Community and Conservation Reserves	Lack of trust among local people about forest Deptt. Largely from belief that they will be debarred from using the area
	2) Sensitization of Judiciary and associated Deptts	Workshop highlighting the status	Judiciary will be sympathetic to plight of riverine system and dolphin in particular	Workshop after 3 years	Sensitization of Judiciary and associated Deptts	None in given time frame	None
	3) Review existing Fisheries Act and Policy	Review by experts and stakeholders the existing rules and policies in fishery sector	The existing rules and policies can be amended on the basis of credible data	3-5 years	Draft Law and Policy changes	Workshop with stake holders and legislators with critical overview and positive outcome	Different Government Deptts will not be amenable to suggestions

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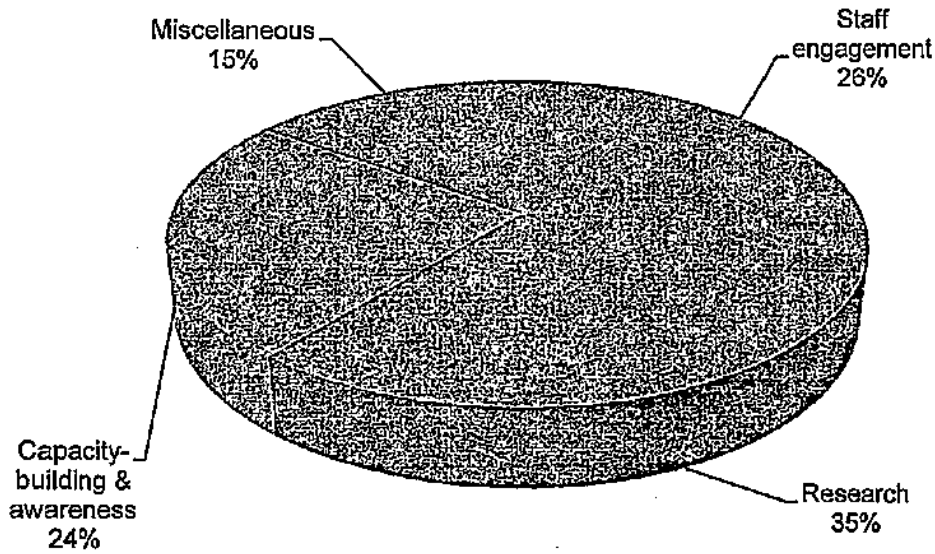
Budget

Staff engagement	4 Project Scientists (2 ecologists, 1 sociologist, 1 veterinarian)	2,688,000	2956800	3252480	3577728	3935501	16,410,509
	2 Project Associates (2 IT & Communication)	542,400	1084800	1193280	1312608	1443869	5,576,957
	10 Project Fellows (6 ecologists, 2 sociologists, 1 remote sensing, 1 genetics)	2,304,000	3840000	4224000	4646400	5111040	20,125,440
	4 Project Assistant Grade 1 (2 ecologists/IT, 1 sociologist, 1 veterinary assistant)	0	729600	802560	882816	971098	3,386,074
	3 Project Assistant Grade 2 (1 ecologist/IT & 1 veterinary assistant)	480,000	528000	580800	638880	702768	2,930,448
	10 Field Assistant Grade 1 & interns	900,000	990000	1089000	1197900	1317690	5,494,590
	Project Management Unit at WII (part cost)	949,056	996509	1046334	1098651	1153583	5,244,132
	Total staff engagement costs	7,863,456	11,125,709	12,188,454	13,354,983	14,635,549	59,168,151
Research	Computers and communication equipments	3,700,000	500,000	500,000	300,000	200,000	5,200,000
	Software purchase, development and technical services	2,800,000	1,000,000	1,000,000	500,000	500,000	5,800,000
	Research & genetics lab (equipment part cost & sample analysis charges, RS-GIS lab & technical services)	5,200,000	1,000,000	1,000,000	500,000	500,000	8,200,000
	Dolphin, associated fauna & habitat monitoring equipment (Hydrophones, Sonar, Water quality sampling unit, GPS, Binoculars, Spotting scopes, Field microscopes, Pingers, fish finders, Unmanned aerial and underwater vehicles etc.), accessories (battery, stationary etc.) and chemicals	3,700,000	500,000	500,000	500,000	500,000	5,700,000
	River Survey (boat & vehicle hiring charges)	5,720,000	10,080,000	9,280,000	9,280,000	9,280,000	43,640,000
	Payment to additional field survey staff	576,000	576,000	576,000	576,000	576,000	2,880,000
	Travel and daily allowances	1,300,000	1,300,000	1,300,000	1,300,000	1,300,000	6,500,000
	Field station and office rental & maintenance charges	500,000	500,000	500,000	500,000	500,000	2,500,000
	Total research costs	23,496,000	15,456,000	14,656,000	13,456,000	13,356,000	80,420,000
Capacity building & awareness	Creation of Dolphin Sanrakshak Network for incentive based conservation (payment to network members for survey & communication, use of pingers & reflectors, dolphin oil alternatives)	4,800,000	9,600,000	9,300,000	9,300,000	8,500,000	41,500,000
	Publicity materials (movie, radio spots, posters, handouts, theater groups, material for educational institutions, media collaborations & stakeholder meetings)	1,000,000	1,000,000	500,000	500,000	500,000	3,500,000
	Workshop and training of forest staff, researchers & other stakeholders	1,000,000	1,000,000	1,000,000	1,000,000	500,000	4,500,000
	Rescue and verinary facility (infrastructure, equipment, labour, transport, medicines & equipment/infrastructure maintenance)	1,000,000	1,000,000	1,000,000	1,000,000	1,000,000	5,000,000
	Documentation, publication & communication of results	100,000	200,000	200,000	200,000	300,000	1,000,000
	Total capacity-building & awareness costs	7,900,000	12,800,000	12,000,000	12,000,000	10,800,000	55,500,000
	Miscellaneous (contingency, unforeseen expenses & institutional requirements)	6,740,544	6,518,291	7,155,546	7,189,017	7,208,451	34,911,849
		46,000,000	46000,000	46,000,000	46,000,000	46,000,000	230,000,000

SUMMARY OF BUDGET

Head	Year 1	Year 2	Year 3	Year 4	Year 5	Total
Staff engagement	7,863,456	11,125,709	12,188,454	13,354,983	14,635,549	59,168,151
Research	23,496,000	15,456,000	14,656,000	13,456,000	13,356,000	80,420,000
Capacity-building & awareness	7,900,000	12,800,000	12,000,000	12,000,000	10,800,000	55,500,000
Miscellaneous	6,740,544	6,618,291	7,155,546	7,189,017	7,208,451	34,911,849
Total costs	46,000,000	46,000,000	46,000,000	46,000,000	46,000,000	230,000,000

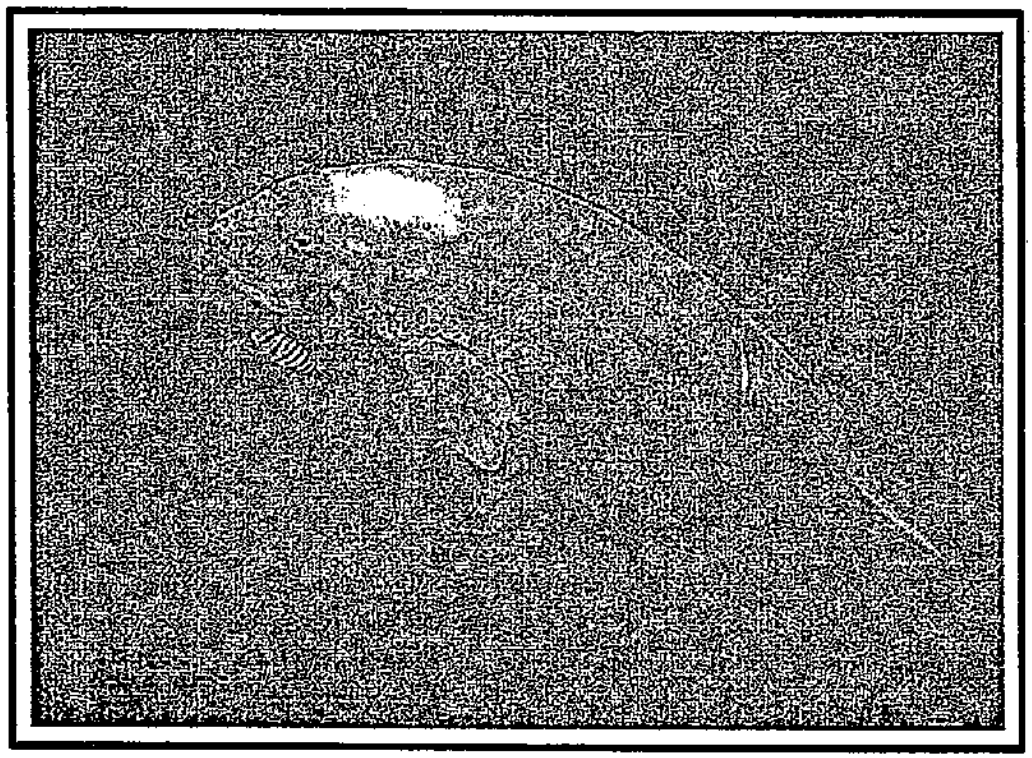
PIE CHART SHOWING BUDGET ALLOCATION FOR VARIOUS ACTIVITIES



Annexure-III

PROJECT TITLE

Recovery of Dugongs and Their Habitats in India: An Integrated Participatory Approach



Implementing agencies:

1. Wildlife Institute of India
2. State Forest Departments –Gujarat, Tamil Nadu, Andaman & Nicobar Islands
3. Indian Navy and the Indian Coast Guard

Collaborating agencies:

1. National Centre for Sustainable Coastal Management (NCSCM)
2. Indian Institute of Science, Education and Research – Kolkata (IISER-K)
3. Central Marine Fisheries Research Institute (CMFRI)
4. GEER Foundation, Gujarat
5. Centre for Marine Living Resources and Ecology (CMLRE)
6. International Collective in Support of Fishworkers (ICSF)
7. Bay of Bengal Program (BOBP)
8. Local NGOs

Funding Agency:CAMPA, Ministry of Environment,-Forests and Climate Change

Budget:Rs. 23.58 Crore (Annexure-I& II)

Timeline:September 2015 – March 2020

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1. Project Background

Dugong (*Dugong dugon)* also called as 'Sea Cow' is one of the four surviving species in the order Sirenia and the only existing species of herbivorous mammal that lives exclusively in the sea (Heinsohn, 1972). Dugongs are naturally found in calm sheltered, nutrient-rich water, generally in bays, shallow island and reef areas which are protected from strong winds and heavy seas (Heinsohn et al.,1977) and which coincide with extensive seagrass beds (Marsh et al., 2002) and such seagrass habitats are still available in Gulf of Mannar, Palk Bay, Gulf of Kutch and Andaman and Nicobar islands in India (Kannan et al., 1999). However, dugongs are not confined to only inshore waters and have been sighted near reefs up to 80 km offshore in waters up to 37 m deep (Ripple, 1999). The population of dugongs in India is expected to be less than 250 individuals that too in highly fragmented conditions. Several reasons have been attributed to their population decline, some of which include sea grass habitat loss and degradation, gill netting, disease, chemical pollutants, indigenous use and hunting.

The National Board for Wildlife under the Chairmanship of the Hon'ble Prime Minister of India constituted two Sub-Committees comprising conservation experts for recovery of threatened terrestrial and aquatic species in India. These Committees have developed *Guidelines for Threatened Species Recovery Plan* and chosen a threatened aquatic marine species,Dugong, for preparation of recovery plans in the first phase. In this context, WII has herewith proposed to initiate the implementation of threatened aquatic species recovery programs for dugongs in partnerships with various stakeholders including the State/UTs Forests Departments under the auspicious of CAMPA.

Further, in order to conserve and manage the Dugongs at global level, the 7th meeting of the Conference of Parties to the Convention on Migratory Species (CMS) had passed a resolution and urged all Dugong range countries to cooperate among themselves to develop and adopt a 'Memorandum of Understanding' and an Action Plan for the Conservation and Management of Dugongs throughout the species range. In this connection, the Government of India has also signed this Memorandum of Understanding in April 2008 to strengthen the ongoing conservation programme of dugongs and their habitats in the Indian water with the support of international community.In this context, the Ministry of Environment, Forests and Climate Change (MoEFCC)of the Government of India constituted a 'Task Force for Conservation of Dugongs' to look into the entire gamut of issues related to conservation of dugongs and implementation of the 'UNEP/CMS Dugong MoU' in India. This task force will also facilitate for a leading role in the South Asia Sub-region with respect to dugong conservation. The Task Force had prepared the 'National Action Plan for Dugong Conservation in India'. This project supported by the MoEFCC under the auspicious of CAMPA is to initiate the implementation of the 'National Action Plan for Dugong Conservation in India' jointly with various stakeholders especially the State Forest Departments and other line agencies and the local communities.This five-year project is to initiate the conservation actions identified in the 'National Action Plan of Dugong in India' with expectation that the populations and habitats of dugong in India would recover within two decades.

1.1 Status of Global distribution of Dugong and their habitats

Dugongs are classified on the global Red List of IUCN as 'Vulnerable to extinction' (Marsh, 2008) and are included in Appendix I of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES, 2015). Dugongs only occur in tropical and sub-tropical waters of the Indo-Pacific region. Their range is extensive, spanning 37 countries and territories from East Africa to Vanuatu (Marsh et al., 2002). Approximately 85,000 of the world's dugongs are found in the inshore waters of northern Australia (Marsh & Lefebvre, 1994) which is likely to be atleast three-quarters of the global population, possibly even more (Marsh et al., 2002). The second-largest dugong population occurs in the Arabian Gulf where the population was estimated in 1987 at 7,310 dugongs (Preen, 1989; Preen et al., 1989). Elsewhere, populations are small and fragmented and in some areas, such as Mauritius, the Maldives and parts of Cambodia and Laos, dugongs may already have become extinct (Marsh et al., 2002).

1.2 Status of Regional distribution of Dugong and their habitats

Historically, the dugong distribution in India was reported as abundant but limited to Andaman and Nicobar Islands, Gulf of Mannar, Palk Bay, Gulf of Kutch, and Lakshadweep Islands (Annandale, 1905; James, 1974; Jones 1967, 1981; LalMohan, 1963; Nair *et al.*, 1975; Silas, 1961; Marsh et al., 2002). The most favored dugong habitats were the Gulf of Mannar, Interview Island and several inlets and bays around the Little Nicobar and Great Nicobar. About 250 dugongs were illegally caught and butchered at the villages of Kilakarei and Peripattinum alone between April 1983 and August 1984 (Silas and Fernando, 1985). This information clearly shows that once the Gulf of Mannar had a good population of dugong but due to illegal take of this species let the population under threat. Marsh (1989).concluded that Palk Strait and the Gulf of Mannar should be important areas for dugongs in India. The status of dugongs in this region is unknown, suspected to be almost completely depleted (Marsh et al., 2002).

There were sporadic records of dugongs on the west coast of peninsular India (Frazier &Mundkur, 1990), however, the only known dugong population remaining in western India is in the Gulf of Kutch (Lal Mohan, 1963; Frazier &Mundkur, 1990). Due to intensive fishing, pollution and various developmental activities, the dugong population in the Gulf of Kutch is on the verge of extinction (Singh, 2003). Dugong population off-coast of Lakshadweep Islands also seems to be extinct as there are no recent sightings of this species in this region.

Dugongs were common in Andaman & Nicobar Islands during the British era but steeply declined later due to poaching and habitat destruction. Dugongs were reported in Ritchie's Archipelago and Dugong Creek in Little Andaman are/were well-known areas for dugong in Andamans. Dugongs are not found in Dugong Creek at present. Moreover, large populations of Andaman & Nicobar islands are no longer seen, and numbers are believed to have been declining since the 1950s (Das, 1996).

Dugongs continue to occur in Gulf of Mannar and Palk Bay along the east coast and in Gulf of Kutch along the west coast of India. Dugongs also occur in Andaman and Nicobar islands. Results of a national level interview-based survey conducted by the MoEFCC, Government of India with help of GEER Foundation, Gujarat on dugong population and also observations made by the Central Marine Fisheries Research Institute and various other organizations in India have revealed that the dugong

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populations all over India are at the verge of extinction. At present, it seems that the largest populations of dugong in India are in Gulf of Mannar and Palk Bay region followed by Andaman and Nicobar islands, although the population size is presumed to be very small (Sivakumar, 2006; Choudhury and Sivakumar, 2008). Dugong population in Gulf of Kutch is already critically endangered (Singh, 2003). Tsunami of 2004 damaged much of the dugong habitats in the Nicobar regions, further threatening the dugong population here (Sivakumar, 2006). However, quantitative data on the status of the population of dugong in India is not available.

In 2009, the population of dugong in India was estimated between 131 and 254 individuals using an interview based survey conducted by the GEER Foundation. Of these, about 77 to 158 individuals were suspected to be occurring in the Gulf of Mannar, 44 to 81 individuals in the Andaman and Nicobar Islands and 10 to 15 dugongs were estimated in the Gulf of Kutch (Pandey et al., 2010).

Region-specific threats to the dugong and its habitat were recently identified by the Wildlife Institute of India (Sivakumar and Nair, 2013). Fishing is a major threat to dugong in Gulf of Mannar, Palk Bay and Gulf of Kutch, poaching/hunting is prevalent in Andaman and Nicobars, and pollution seems to be major threat to dugongs in Gulf of Kutch (Sivakumar and Nair, 2013). Occupancy models were built to identify critical dugong habitats using dugong sighting data from the past five years (2008 to 2012). The range of variables that influenced occupancy and detection were also assessed. Dugong occupancy was greatest in the Gulf of Mannar and Palk Bay, followed by the Andaman and Nicobar Islands, and lowest in the Gulf of Kutch. At present, the overall occupancy of the dugong in Indian waters is estimated to be 11% of the historical distribution (the 1950s) area. Only 21% of the area sampled in Tamil Nadu was found to be occupied by dugongs. The corresponding proportion was 12% in the Andaman and Nicobar Islands and 1% in the Gulf of Kutch. Status of dugong in some of the inaccessible areas such as West Coast of South and Middle Andaman were not known as these areas are Tribal Reserve. Overall, the dugong distribution range has significantly decreased by about 85% in the distribution range of the dugong in India (Sivakumar and Nair, 2013). Similarly, there is an estimated 60% decline in dugong occupancy in last 20 years in Andaman and Nicobar Islands (Dsouza et al., 2013).

1.3 Major Threats

Several reasons have been attributed to the dugong population decline, some of which include seagrass habitat loss and degradation, gill netting, disease, chemical pollutants, indigenous use and hunting, etc. Dugongs are vulnerable to anthropogenic pressures as they are solely dependent on seagrasses in coastal areas which now have been seriously damaged by fishing, trawling and dredging, etc.(Marsh *et al.*, 2002, Nair *et al.*, 1975, Das and Dey, 1999). Dugongs have also been hunted for their meat, oil, hides, bones and teeth. However, hunting has been totally banned in several countries including India.

Feeding grounds of dugong i.e. sea grass beds are highly degraded due to changes in the fishing methodology. Traditionally, fishermen used non-mechanized boats for fishing in the shallow waters; however, due to modernization of fishing technology, traditional crafts were gradually replaced by mechanized crafts like bottom trawlers that cause severe damage to seagrass beds. Moreover, water pollution and siltation have also hampered this unique habitat of the dugong. Although dugong is getting highest protection by law but still there have been reports of poaching done by fishermen for

dugong meat. In Ritchie's Archipelago, growing tourism activities especially high-speed vessels and speedboats have become a major threat for local Dugong population.

1.4 Current Status of Regional Conservation

The Dugongs are protected under the Schedule-I of the Wildlife (Protection) Act 1972, which provides the maximum protection to a species in the Indian Territory and also prevent any trade on this species. The Dugong population across the world is also declared as Vulnerable by IUCN and listed in Appendix-I of CITES, which prevent international trade on this species. Being a signatory, the Government of India strictly adheres to the CITES rules and regulations to prevent trade on protected endangered species including dugong.Moreover,large portions of dugong habitat in India have been included in the existing Wildlife Protected Areas Network, for example, Gulf of Mannar Marine National Park, Gulf of Kutch Marine National Park, M.G. Marine National Park etc. A study carried out by Ilangakoon et al (2008) during 2004 had also revealed that the incidental catch of dugong by fishermen is significantly lower in Indian part of Gulf of Mannar than Sri Lanka and it was due to awareness and protection provided by joint efforts of Government of India and Tamil Nadu Forest Department. Government of India has also signed the MoUon the Conservation and Management of Dugongs and their habitats throughout their range in April 2008 to strengthen the ongoing protection and management of dugongs and their habitats in the Indian water with the support of international community. Additionally Government of India along with State Forest Departments has initiated awareness programme among fishermen communities to minimise the incidental capture of this species and also to protect their sea grass habitats (Choudhury and Sivakumar, 2008). Further, the National Board for Wildlife under the Chairmanship of the Hon'ble Prime Minister constituted two Sub-Committees comprising conservation experts for recovery of threatened Terrestrial and Aquatic species in India. These Committees have already developed Guidelines for Threatened Species Recovery Plan and also selected certain threatened species on a priority basis that include dugong.

2. GOALS AND OBJECTIVES

The broad goals and objectives of this project are as follows:

Goal 1: Species conservation and management

Assess Dugong population status through advanced census techniques and determine its abundance and distribution, identifycritical habitats, classify threats and develop site-specific monitoring plan to reduce hunting and incidental entanglements.

Goal 2: Habitat conservation and management

Characterize the critical Dugong habitats, reduce direct and indirect threats, control modifications in and around the habitat and improve habitat quality through management interventions and participatory approaches.

Goal 3: Creating awareness about Dugong and its habitats

Raise awareness on the species and encourage the participation of the local communities; include other stakeholders like fisheries department and religious heads in conservation efforts; enhance Dugong conservation program by spreading awareness on a national scale.

Goal 4: Capacity-building of the State Forest Department & local communities
Enhance the capacity of the State Forest Department staff and develop/implement smart patrolling tools to improve protection enforcement; train forest staff and local communities in underwater surveys for long-term habitat monitoring.

3. Scope of work

3.1 Species conservation and management

Wildlife Institute of India in collaboration with State Forest Departments, other line departments, Indian Coast Guard, Indian Navy, NGOs and local communities would carry out detailed population and habitat surveys to address the gaps in the knowledge of Dugong ecology in its range states. This program will involve State Forest departments and local communities of three state/UTs viz. Gujarat, Tamil Nadu and Andaman & Nicobar Islands. Existing Dugong habitatshave already been identified by conducting extensive field and questionnaire surveys by Wildlife Institute of India. Intensive aerial surveysusing aircrafts and drones would be conducted jointly with the Indian Coast Guard and State/UTs Forests Departmentsto generate baseline information on the occupancy and population statusof Dugongs in all three regions in India. Further,drone-based continuous monitoring will be conducted to monitor anddetect changes in populations. Information on dugong behaviour, habitat requirement and associations with other fauna and flora will be simultaneously collected for successful restoration of dugongs and their habitat.

Nevertheless, low population size, fragmented habitats in marine habitats and high mobility makes it challenging to gather information on dugong biology. To facilitate population recovery and assess long-term population viability, we also need to study population genetics of dugong populations across their habitats in the Indian seas. This genetic viability assessment would help us to intervene in the genetic diversity of the population by mixing of stocks through translocation if required. Molecular techniques would be used to investigate the populationgenetic structure of dugongs based on both mitochondrial and nuclear markers.

Further, advanced monitoring methods like Unmanned Aerial Vehicles (UAVs) or drones will be used in monitoring native populations of dugongs. Dugong field camps will be established at all study sites in Gulf of Kutch, Gulf of Mannar, Palk Bay and Andaman & Nicobar Islands to support drone-based monitoring. Acoustic surveys will also be attempted for identified dugong populations to understand social behaviour of the species.The vocalisation patterns differ for the calving, non-calving herds and solitary individuals (Ichikawa et al., 2012) and acoustics can reveal their distribution patterns to assist space-based management of their populations.

Traditional knowledge of fishermen in the Palk Bay reveals that the population here seems to be migrating between the coastal waters of India and Sri Lanka. Therefore, this project proposes to use satellite tracking of Dugongs for mapping their movements and fine scale habitat use and support conservation planning of its habitats. Ten Dugongs will be tagged and monitored remotely at a later stage of the project after the initial baseline surveys. Satellite tracking will provide vital information on seasonal movement patterns, critical habitats, interaction with fishing vessels and connectivity between seascapes. The crucial information generated will be used to identify and delineate *restrictive-use zonesor open sea enclosures*where a compensatory mechanism can be initiated.

The main causes of mortalities of Dugong individuals will be assessed by interviewing the local communities, forest department staff; other stakeholders; and with direct field based observations. Incidental fishery entanglements are a major reason behind dugong mortality (D'Souza et al 2013; Marsh et al 2002) and conservation measures will be taken to regulate harmful practices like gillnetting in dugong habitats. An index of the threats will be developed to reduce the mortalities at the identified habitats. A compensatory scheme will be initiated at small scale around the prime dugong habitats identified by the first year surveys where direct threats like fishing net entanglements will be minimized and fishing activity regulated. A compensation model will be developed in consultation with forest staff and dependent communities and evaluated based on indicators such as reduced mortalities/boat strikes, increased sightings etc. A larger scale compensatory mechanism can thus be implemented by the State Forest Departments in dugong range areas with funds available from state CAMPA to involve more stakeholders at later stages.

A Marine Mammal Rescue and Rehabilitation Facility (M2R2F)would be developed on trial basis in Palk Bay and Gulf of Mannar region, where many strandings of dugongs have been reported in the recent past. This unique facility would be developed by providing additional capacity to existing veterinarians and managers in the region to handle the rescued dugongs as well as other marine mammals. The facility would be simultaneously developed in selected sites in Gujarat and Andaman & Nicobar Islands as well identified thorough applied research in the first three years. This facility would also look into certain aspects of marine mammals diseases in the region. The support of the Civil Construction Unit (CCU) of MoEFCC would be taken for construction of M2R2F at the project sites with the help of the State Forest Department.

3.2Habitat conservation and management

The seagrass beds which are the foraging grounds of Dugong will be intensively studied with boat based surveys in the previously identified sites (D'Souza et al 2013; Sivakumar& Nair 2013). Seagrass meadow characteristics including depth, wave exposure, species composition, shoot density and patchiness will be measured by undertaking underwater assessments (Lal et al 2010). Habitat requirements of dugong and its associated fauna would be studied, so that, a better habitat management as well as habitat restoration programme would be taken up during this project period.

Ecological Quality Status (EcoQS) of seagrass habitats frequented by dugongs will be assessed using seagrass-associated benthic organisms (as epifauna) or in underlying sediment (infauna) where seagrass grow, as a tool for such evaluation. The EcoQS map will help us to ascertain sectors of

seagrass bed that need immediate protection and ultimately help in conservation of dugong population by effective habitat management. Additionally, the EcoQS maps can help us to better evaluate the ecosystem services rendered by seagrass habitats and its economic value from monetary perspective.

Water quality parameters will be measured seasonally to assess the impact of pollution, turbidity, and silt deposition etc. on the health of the seagrass meadows. Urgent management interventions will be suggested based on the assessment to reduce any negative impact thereof.

Threats to seagrass ecosystems will be monitored with intensive boat surveys at all the sites. Harmful fishing practice like bottom trawling at critical dugong habitats will be regulated especially during the breeding seasons and at seagrass habitats. Possibility of seagrass transplantation (Katwijk et al 2009) would be studied during this project period.

Critical Dugong Habitats that are outside the Protected Areas would be monitored intensively. A small portion of seagrass beds approximately 12 sq.km area would be marked in the Palk Bay region as a *Control HabitatEnclosure* free from fishing and other anthropogenic activities. Changes in the habitats and its fauna would be monitored inside this enclosure to understand the fishing pressure on seagrass habitats. Further, economics of ecological services of this enclosure would also be studied to compensate the fishermen who incur loss due to this enclosure monitoring.

Moreover, the Governments of State/UTs of Dugong range would be encouraged to bring the dugong habitats that are outside PAs under the management regime exclusively governed by the local communities especially the fishermen communities. Management of these identified areas would be facilitated by the State/UTs Fisheries and Forest Departments with support of State/UTs CAMPA Funds.

3.3 Creating awareness about Dugong and its habitats

Extensive campaigns for spreading awareness on dugong conservation will be conducted in and around the project sites to involve fishers, forest staff, school students etc. Wildlife Institute of India in association with related organizations would develop nature education and awareness materials for general public, school and college students, fishermen communities etc. Local stakeholders will be identified through these campaigns and information in the form of reading material; posters etc. will be distributed to generate interest and awareness. Fishery societies at all the sites will be targeted with these campaigns and enthusiastic volunteers will be identified and trained for reporting dugong sightings. An incentive-based *Dugong Volunteer Team* will be created where all the direct sightings, strandings, entanglements and mortalities can be reported in real time using mobile phones equipped with cameras. Religious heads of different communities at the project sites will be involved in the project to reach out to the masses about the need to conserve dugongs.

A documentary film on dugong titled 'Sea Angel' aimed to educate people towards ecology, behaviour, ecological services of dugongs and their habitat etc would be produced during the project.

Further, the progress of this species recovery project would also be documented for spreading knowledge about the conservation actions.

3.4 Capacity-building of forest staff and local communities

A capacity needs assessment would be carried out for the better management of dugongs and their habitat in India. Based on the capacity need assessment, special capacity building programs would be initiated for frontline staff and managers from the dugong range states.

Participantsfrom the three states of Gujarat, Tamil Nadu and Andaman & Nicobar Islands will be trained at WII for Post Graduate Diploma in Advanced Wildlife Management (9 months) and Certificate Course in Wildlife Management (3 months). Frontline forest staff of the three states will also be involved in all the field- based sampling and research to train them for long-term species monitoring. Additionally, a 15 - day special training on SCUBA diving, snorkelling and underwater biodiversity monitoring would be carried out for the frontline staff of the State Forest Department, members of the Dugong Volunteer Teams and researchers in the dugong habitats.

A three-day on-site training will be provided to concerned stakeholders for providing a holistic approach towards Dugong conservation and management. The stakeholders involved will be representatives from frontline forest staff, local communities, local administration, students, researchers and private players.

An integrated management plan for dugong conservation will be developed at five sites in consultation with state forest department and local communities to conserve prime dugong inhabited areas. The project proposes to initially target Gulf of Kutch Marine National Park, Gulf of Mannar Marine National Park & Palk bay; and Rani Jhansi National Park & Mahatma Gandhi Marine National Park (A & N islands).

Additional facilities required for management of dugongs and their habitats inside and outside PAs would be identified by the Wildlife Institute of India and established by the concerned State/UTs with the State CAMPA Fund. Facilities would largely be required for protection and monitoring of dugongs, underwater monitoring of seagrass beds and associated fauna, monitoring of marine pollution etc.

4. Approaches/ Methods

Wildlife Institute of India in collaboration with its partner institutions/NGOs and State Forest Departments will initiate work as discussed in the section 3 in dugong range areas. The following activities will be taken up by WII to achieve the goals set up for Dugong recovery:

4.1Participatory assessment of dugong populationsand theirhabitat

Populations of dugong would be assessed using aerial surveys jointly with the Coast Guard and the Indian Navy. Aerial strip transects will be conducted for estimating the population density of

Dugongs (Marsh & Sinclair 1989; Marsh *et al.* 1994) at the three project sites i.e. Gulf of Kutch, Gulf of Mannar Biosphere Reserve & Palk Bay and Andaman & Nicobar islands. The survey areas will be demarcated using satellite imagery on a GIS domain and survey points will be identified. A small fixed wing aircraft (privately hired or coast guard supported) will be flown at a ground speed of 100 km h^{-1} at an altitude of around 80 to 100 m above sea surface. Transect strip width will be kept upto 400 m (200 m on each side of the aircraft). The survey crew will include a team of two observers on each side of the aircraft, who will record observations separately on tape recorders. Dugong group size, number of calves and number at the surface will be recorded for each sighting along with GPS co-ordinates, altitude and time. Environmental parameters such ascloud cover, sea state, turbidity will be recorded every 15 min. The record of each flight will be audio-taped for post-survey checking. Apart from dugongs, sightings of other marine mammals and turtles will also be recorded during the aerial survey. The location of seagrass beds would also be recorded during the aerial surveys for subsequent ground-truthing using boat-based surveys (Marsh et al 2002).

Based on prime habitats of dugong identified through aerial surveys, intensive boat surveys will be carried out using straight line transects. Number of individuals sighted,sighting distance and sighting angles will be measured to estimate the density of dugongs in *Critical Dugong Habitats* (CDHs).

Extensive field data will be collected in the CDHs divided into grids mapped on a GIS domain before collecting the data. Sampling will be done using SCUBA diving/snorkelling during clear weather and low tide conditions. At each grid, vegetation plots will be established to assess the health of the seagrass beds. Data on species composition,shoot density, percent cover, blade/ leaf height, substrate, distribution etc. will be collected seasonally. Associated benthic fauna will also be quantified from these plots and data on species composition will be collated. Dugong feeding signs will be recorded as and when encountered. Along with the seagrass data other environmental and habitat variables like, depth, water temperature, nutrients, salinity, bed characters, human disturbance etc. will be recorded. In addition to the field data, existing information on sea grass data, maps from Forests Department and other agencies will be used for the base references.

All the field assessment and monitoring work would be carried out with active involvement of local communities and State Forests Departments so that the programme would be institutionalized and carried forward.

4.2Participatory monitoring of dugong populations and their habitats

UAVs or drones fitted with digital cameras will be employed to survey seagrass beds known to be frequented by dugong herds where a series of parallel line transects will be laid (Hodgson et al 2013). The effective transect width will be calculated on the basis of width of view available at each altitude (500-1000ft). The transects will be equally spaced and flown over regular intervals on monthly/fortnightly basis to obtain crucial data on movement, habitat-use and improved count of the identified dugong populations.

Satellite tracking of dugongs would be conducted for mapping their movement patterns and fine-scale habitat use. Up to ten adultdugongs (without calf) will be captured under standard circumstances and with appropriate methods (Lanyon et al. 2006; Sheppard et al. 2010) at the

selected project site (Gulf of Mannar or A & N islands).Argos PTT/ GPS satellite tags will be fitted on to the body using a harness (Sheppard et al 2010) and monitored by transmitting location information to remote computers.

Seasonal sampling will be undertaken in seagrass habitats which are frequented by dugong population based on NaGISA protocol (http://nagisa.cbm.usb.ve), in addition to seagrass sites which are yet to be foraged by dugongs. Epiphytic benthic fauna and sediment samples for benthic infauna analyses will be collected using hand held corers. At the time of sampling, environmental *in situ* parameters of surface water (pH, temperature, salinity, dissolved oxygen, secchi depth, depth, total alkalinity) along with measurement of environmental parameters of underlying sediments on which seagrass beds are found will be undertaken. Dissolved nutrients of surface water and sediments will be collected and analyzed in the laboratory using spectrophotometry as well as Inductively Coupled Plasma-Mass Spectrometry (ICP-MS). Benthic fauna will be enumerated, sorted and taxonomically identified using standard keys. Imaging of taxonomically intractable benthic faunal groups will be undertaken using Field Emission-Scanning Electron Microscopy (FE-SEM) as well as using high resolution Bright-field microscopy. The ECoQ analyses will be undertaken for seagrass habitats, mapped and vulnerable seagrass habitats will be identified based on analysis of generated benthic faunal datasets and identification of such seagrass habitats is important for long-term conservation of dugong population.

Along with ecological monitoring, we will also use molecular genetic approaches to assess population size, genetic diversity, population structure, gene flow and its' rate and direction and demographic patterns during this project. As no such work has been done in any Indian Marine mammal, we will develop most of the methods during the project tenure. A number of techniques have been described for sample collection from marine mammals (for example Lanyon et al. 2010), but initially sampling will be done from tagged individuals, and opportunistically collected from dead and stranded animals during fieldwork. In addition, we will also collect opportunistic dugong faecal samples as biological materials. Samples will be collected in sterile Eppendorf tubes and stored in absolute ethanol. The samples will be transferred to - 20°C freezer in the laboratory along with all associated location data. DNA from tissue samples will be extracted using Qiagen Tissue DNA extraction kit following manufacturers' protocol. We will then standardize both mitochondrial (mtDNA) and nuclear (microsatellite and sexing) markers for further genetic analyses. A number of genetic studies on dugongs (McDonald 2005; Broderick et al. 2007; Bushell 2013; Blair et al. 2013, Seddon et al 2014; Cope et al. 2015) will help us to find useful markers. Following selection and standardization of suitable markers we will amplify them from field-collected samples. PCR products will be purified using Exo-SAP mixture and then sequenced from both directions in an ABI sequencer. Amplified microsatellite products will be run along with suitable size standards for genotyping and alleles will be called using program GENEMARKER (Softgenetics Inc., USA). The mtDNA sequences will be aligned and assembled using MEGA ver 6 (Tamura et al. 2005). Summary statistics of genetic diversity data will be calculated with program DnaSP (Librado and Rozas, 2009) and ARLEQUIN (Excoffier et al. 2005). Spatial genetic structuring will be examined by using STRUCTURE v. 2.3.4 (Pritchard et al. 2000) with nuclear microsatellites and BAPS V2 (Corander et al. 2004) with mtDNA. To detect gene flow among different populations we will use multiple approaches with our genetic data. First, we will use program STRUCTURE 2.3.2 (Pritchard et al. 2000) to detect first-generation migrants in our sampled populations. We will use prior population

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information in the USEPOPINFO option with run conditions described earlier. Further, we will use 'Migrant detection' function described in program GENECLASS 2.0 (Piry et al. 2004) to confirm the first generation migrants. This method allows detection of migrants even when the overall differentiation between populations is low. Finally, we will use Bayesian assignment approach implemented in program SCAT ver. 2.0 (Wasser et al. 2004, 2007; Mondol et al. 2014) to support our GENECLASS and STRUCTURE results. The advantage of this approach lies in its use of geographic location information from the reference samples, and resulting assignment of each unknown individual to a geographic location. We will initially conduct exploratory runs with multiple combinations of input parameters (burn-in, thinning and iterations) with the entire data to select the best parameter combinations, and finally use the best parameter combination for our genetic data to identify migrants (Mondol et al. 2014). To estimate the direction and rate of migration we will use coalescent program LAMARC (Kuhner 2006). Effective population size will be calculated using program LAMARC (Kuhner 2006). Estimation of population decline will be determined using both qualitative (BOTTLENECK; M-Ratio, LAMARC) as well as quantitative (msVAR) approaches.

Acoustic surveys have also been planned on a trial basis to understand social behaviour of dugong populations at the project sites. A towed stereo hydrophone array will be operated from the survey boats in dugong around the focal area at a towing speed of 10 km/h. Sufficient distance (500 -1000 m) will be kept between parallel cruise lines to cover a wider area of dugong distribution (Ichikawa et al 2009, 2012).

All the field monitoring work would be carried out with active involvement of local communities and State Forests Departments so that the programme would be institutionalized and carried forward.

4.3 Threat assessmentandmitigation

Threats to dugongs and their habitats will be quantified by a two-pronged approach of indirect and direct information gathering. Previously conducted questionnaire surveys (Sivakumar& Nair 2013) will be used as baseline for conducting extensive verbal interviews of local fishers, villagers, trawl operators, forest staff and other stakeholders. Information on dugong and seagrass distribution, abundance, traditional knowledge, beliefs, traditional/modern use, sighting reports, and estimates of mortalities will be generated to understand threat levels of various activities.

Identified CDHs in the study areas would be monitored for fishing/shipping activities. Number, type of boats, number of fishermen, demography of fishermen, type of fishing gear, time spent near the habitat, CPUE, cost of catch etc. would be recorded for all boats. These boat surveys would be supplemented with information gathered from interview surveys described above. These details would help to understand the resource use pattern and dependency level of fishermen community in the critical dugong habitat of Gulf of Kutch, Gulf of Mannar& Palk Bay and A & N islands.

Water samples will be collected monthly from select points within the CDHs to assess the pollution levels, turbidity and other parameters. Causative factors of pollution like presence of fishing

boats/trawlers, ships etc. will also be noted down for preparing management guidelines for the CDHs.

The data generated from interviews and direct boat based surveys would be used to identify areas of repeated conflicts and mortalities. A compensatory scheme will be initiated for fishermen who will be asked to reduce the usage of gill nets in and around the dugong habitats and also encouraged to release any individual caught in the fishing nets. Photographic evidence would be required to provide compensation on a case to case basisaround the prime dugong habitats. Compensation to verified release events or no-fishing practices will be provided on a smaller scale and a model would be developed to implement it on a larger scale. State Forest Departments would be encouraged to make use of this model with funds available from state CAMPA to reduce fishery related mortalities and will be assessed on a regular basis.

Immediate mitigation measures visualized at this stage are to provide incentives to fishermen who rescue and safely release back the incidentally captured dugong. Further, protection and patrolling capacities of the local management authorities who govern the dugong habitat would be strengthened by enhancing their communication facilities and enabling them with smart patrolling tools.

4.4 Capacity building and awareness

Augmenting Dugong conservation efforts of the forest department is necessary for recovery and long-term survival of the populations. Participants from the state forest department of Gujarat, Tamil Nadu and A & N islands will be trained at WII for diploma and certificate courses in wildlife management every year. A 15 -day special training will be organized for selected participants to train them in SCUBA diving, boat surveys and underwater biodiversity monitoring techniques. This training would also involve selected members from local communities and other stakeholders to train them in Dugong monitoring and mentor these as members of *Dugong Volunteer Teams*.

A three-day on-site training on Dugong conservation and management for select representatives of all the local stakeholders will be conducted at the project sites every year. These events would be supported by mobile campaigns to raise awareness on the species and threats to its existence over the coastal districts along the Dugong range habitats.

Infrastructure for a Marine Mammal Rescue and Rehabilitation Facility would be developed initially in Palk Bay and Gulf of Mannar region. The same facilities would be extended to Andaman & Nicobar and Gulf of Kutch subsequently. Marine mammal specific training will be provided to the existing veterinarians and forest managers in the region to handle the rescued dugongs as well as other marine mammals. Special training for handling marine mammals and facilitating their release into the sea would be sought with the help of funds from othersources (e.g. Corporate Social Responsibility funds).Civil Construction Unit of MoEFCC which has aMoU with WII would be brought in to expedite the construction work in consultation with Tamil Nadu Forest Department (subject to land availability and other requirements).

Major fishing villages at each project site will be targeted for awareness campaigns where reading material, posters etc. will be distributed. These campaigns will be conducted in consultation with the

fishing societies operating in these areas and also local stakeholders. The project aims to reach out to over 70 % of the working population in these areas through these campaigns. Five enthusiastic volunteers will be identified at each site and will be trained for reporting dugong sightings. An incentive-based *Dugong Volunteer Team* will be created where all the direct sightings, strandings, entanglements and mortalities can be reported in real time using mobile phones equipped with cameras. Religious heads of different communities at the project sites will be involved in the project to reach out to the masses about the need to conserve dugongs.

A documentary film (tentatively titled *Sea Angel*) has been planned on conservation needs of dugong populations at selected project site for creating awareness at a larger scale.

An integrated management plan for dugong conservation will be developed at five sites in consultation with state forest department and local communities to conserve prime dugong inhabited areas. The project proposes to initially target Gulf of Kutch Marine National Park, Gulf of Mannar Marine National Park & Palk bay; and Rani Jhansi National Park & Mahatma Gandhi Marine National Park (A & N islands).

5. Expected Project Outputs

The outcomes of this project will help in restoring the dugong populations and their habitat in India thorough a participatory approach. This project aims to produce replicable results which can be utilized to aid recovery of other threatened marine mammal species in India.

5.1 Species and habitat recovery

This project would be able to provide comprehensive information on the status, distribution and abundance of Dugong populationsin the states of Gujarat, Tamil Nadu and Andaman & Nicobar Islands at the end of five years. The critical Dugong habitats would be subsequently mapped and improved knowledge on their ecological status will be available for making informed management interventions. Vital information on seasonal movement patterns and population connectivity would be generated to aid long-term population monitoring at all the sites. The threats to the Dugong populations would be enumerated, assessed and mitigation actions would have been put in place to halt species decline and habitat degradation. The fishing resources of the Dugong habitats would show improvement and help enhance the livelihood of the local communities.

5.2 Enhanced management and capacity

The State Forest Department would be better prepared for managing Dugong populations and habitats with knowledge on essential monitoring techniques. The critical habitats will be well-monitored and there would be reduced reports of hunting and fishing net entanglements. The enhanced protection measures would be in place for the critical Dugong habitats and majority of the population will be protected. Infrastructure and trained personnel would be available for treatment of injured/stranded individuals. The local communities would be effectively involved to assist conservation efforts through various participatory approaches. Participatory management of dugongs and their habitats would have involved all concerned stakeholders including production sectors.

5.3 Increased awareness and regional cooperation

The project would be able to generate public interest on Dugongs and threats to their populations and habitats at a wider platform. The fishing communities, villagers, agriculturists, shipping industry, forest managers, and local leaders would have been sensitized and involved in the Dugong conservation program in various roles. Communities would have a larger participation in the species recovery program while government institutions, NGOs, private sectors would support research, conservation and management efforts.

5.4 Long-term Conservation Model for Dugong

Based on the information generated with this project and enforcement of the mitigations measures, we expect to see a substantial recovery of Dugong and their habitats in the range states. However, as per the currently available information, population of Dugongs in Gujarat is threatened with extinction. The successes of this project might be utilized in strengthening the status of this species in India with advanced conservation measures like translocation of individuals. Genetic assessments of existing Dugong populations would be critical in determining the genetic lineages and differentiation levels. This information would be used in re-populating the areas which have lost genetically viable Dugong populations. The Dugong Recovery Plan would ensure that the populations in the current range states and associated habitats and species show a recovery over the next two decades.

6. Budget –Cost Justification& Summary – Annexure –I& II

7. Log frame for Dugong Conservation Action Plan(monitoring indicators)

Goal	Activity	Inputs	Assumption	Implementation Time Frame	Output	Verifiable Indicators and Time	Risks
1) Generating ecological information on Dugong and associated habitats	a) Dugong and associated species assessment and monitoring	Population estimation: Aerial Transects , Boat transect , Drone surveys, Under water detection using hydrophones	Availability of Aerial support, offshore monitoring tools & infrastructure and support of State Forest Dept.	Initial 2 years to cover all three states and later on boat-based surveys to detect changes	Population Estimates	Scientifically acceptable abundance estimates Annual estimates in critical habitats Improvement in Demographic trends 2 Years	Conflict with fishermen may delay the estimation process Possible delay in getting the collaboration of Indian Coast Guard/Navy for aerial surveys Hindrance in continuing monitoring on long term basis i.e. beyond project life
		Dugong and associated species spatio-temporal distribution	Availability of Aerial support, offshore monitoring tools & infrastructure and support of State Forest Dept.	Initial 2 years to cover all three states and later on boat-based surveys to detect changes	Distribution and Habitat use of Dugong and associated species	Scientifically acceptable spatio-temporal distribution data in 2 years' time Seasonal distribution	Conflict with fishermen & shipping industries Delays due to permission issues in international

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Goal	Activity	Inputs	Assumption	Implementation Time Frame	Output	Verifiable Indicators and Time	Risks
						data in critical habitats Factors affecting habitat-use information 2 Years	border/ defence controlled areas
	b) Critical Dugong Habitat mapping & monitoring	Seagrass habitat mapping Associated benthic fauna mapping Monitoring for detecting changes	Availability of offshore monitoring tools, trained manpower, infrastructure and support of State Forest Dept.	Initial 2 years to cover all three states and later on underwater monitoring to detect changes	Seagrass extent and composition Habitat quality Identification of indicator species	Ground-truth data on seagrass habitat extent, quality and composition in 2 years' time Information on deleterious factors affecting habitat quality 2 Years	Conflict with fishermen & shipping industries Delays due to lack of specialised manpower and permission issues in international border/ defence controlled areas
	c) Genetic assessment of Dugong populations	Samples across its range and laboratory analysis	Sufficient sample size will be available	3-4 years	Level of genetic diversity and spatial nature of population will help in taking appropriate mitigation measures	Genetic diversity and level of isolation among spatially isolated populations 3-4 years	Lack of enough samples
2) To enhance capacity of state forest department, local communities & other stakeholders in Dugong conservation	a) Awareness and Training of State Forest Department, local communities and other stakeholders for Dugong Monitoring	Specialised training of Forest Dept. staff Enhancing awareness by inclusive activities	Acceptance and Willingness to implement Availability of specialised tools & infrastructure	Five years to systematically include representative forest staff	Trained forest staff in underwater & offshore monitoring Increased know-how of effective tools and methods	Increased skill level Effective monitoring Reduced threats & mortalities 4-5 years	Loss of Institutional interest and sustenance of activity
		Specialised training of local community representatives Enhancing awareness by inclusive activities	Fishermen will be willing and perceive benefits Forest Dept. and Associated agencies will sustain it on long term basis	Sustained involvement during the entire project duration Will take 2 to 3 years for full functionality	Co-operation in conservation & monitoring Increased awareness	Increased reporting of Dugong entanglement, mortalities and strandings Decline in conflict incidences with fishermen Reduced use of critical habitats	Unwillingness due to perception of threat to their livelihood Lack of long term sustenance

Goal	Activity	Inputs	Assumption	Implementation Time Frame	Output	Verifiable Indicators and Time	Risks
						Improved habitat quality & cover 4-5 years	
	b) Dugong rescue and rehabilitation	Veterinary setup and mobile rescue teams	Infrastructure setup will be created with the help of State Forest Dept. & expert consultants	Full functionality during 4th-5th year project time frame after due experimentation and learning	Decline in mortality of stranded and injured dugongs	Increase in survivorship of rescued dugongs 4-5 years	Lack of infrastructure support Long term sustenance of rescue centre
	c) Documentation of Dugong conservation	Documentary film on Dugong and its habitats, their conservation and threats	Infrastructure support of State Forest Dept. Involvement of local communities	3rd- 5th year	Increased awareness on Dugong conservation issues around the range states Improved public perception of ecosystem services provided by Dugong & its habitats	Increased participation of local communities in conservation efforts 4-5 years	Lack of infrastructure support
3) Increasing participatory management of Dugongs	a) Incentives for rescue and release of entangled dugongs	Compensatory mechanism to motivate safe releases Training of Dugong Volunteer team for efficient rescues	Support of fishermen and state forest department	Sustained involvement from 2nd year onwards	Decline in mortality of entangled dugongs Increased participation of local communities	Increase in survivorship of rescued dugongs Higher reporting of entanglements 4-5 years	Lack of infrastructure support Unwillingness due to perception of threat to their livelihood.
	b) Incentivizing open sea enclosures	Compensatory mechanism to restrict use of enclosure Training of Dugong Volunteer team for efficient monitoring	Support of fishermen and state forest department	Sustained involvement from 2nd year onwards	Decline in incidental entanglement Improved habitat quality Increased participation of local communities	Improvement in habitat quality Improvement in population status of dugongs 4-5 years	Lack of infrastructure support Unwillingness due to perception of threat to their livelihood.

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Annexure- I

Budget and Cost Justification

Activity	Specifications	Amount (in Lakh rupees)					
		Yr1	Yr2	Yr3	Yr4	Yr5	Total
a) Man power	1 Project Scientist	6.7	7.4	8.1	8.9	9.8	41.0
	7 Project Fellow	26.9	29.6	32.5	35.8	39.4	164.1
	6 Field Assistants Grade-1	7.9	8.7	9.6	10.5	11.6	48.4
	6 Field Assistants Grade- 2	6.1	6.7	7.4	8.1	9.0	37.4
	Daily labour	1.0	1.1	1.2	1.3	1.5	6.1
	Project Management Unit (part cost)	15.4	10.5	11.5	12.6	13.9	63.9
Total Cost of Manpower Engagement		64.0	64.0	70.4	77.4	85.1	360.9
b) Capacity Building & Awareness	Capacity Building Training for State Forest Department personnel (Diploma/certificate or other trainings)	0.0	26.0	27.3	28.7	30.1	112.1
	Meetings, campaigns, workshops, preparation of awareness materials & management guides (3 events/state/year with approx. 20 participants/event)	15.0	15.8	16.5	17.4	18.2	82.9
	Specialised training for forest staff & local communities (1 training/state/year with approx. 10 participants/event)	36.0	37.8	39.7	41.7	43.8	198.9
	Documentary film on Dugong Conservation	0.0	0.0	25.0	5.0	5.0	35.0
Total Cost of Capacity building and Awareness		51.0	79.6	108.5	92.7	97.1	428.9
c) Participatory Management	Development and Participatory monitoring of Open-sea Enclosures	15.0	16.5	18.2	20.0	22.0	91.6
	Incentive-based rescue and rehabilitation of Dugong	30.0	30.0	30.0	30.0	30.0	150.0
	Strengthening Communication facilities for improved monitoring	30.0	33.0	36.3	39.9	43.9	183.2

Total Cost of Participatory Management		**75.0**	**79.5**	**84.5**	**89.9**	**95.9**	**424.7**
d) Marine Mammal Rescue and Rehabilitation Facility	Establishment of MMRRF	0.0	5.0	5.0	120.0	120.0	250.0
	MMRRF running costs	0.0	0.0	0.0	12.0	12.6	24.6
	Miscellaneous costs	0.0	0.0	0.0	3.4	3.6	7.0
Total Cost of Marine Mammal Rescue and Rehabilitation Facility		**0.0**	**5.0**	**5.0**	**135.4**	**136.2**	**281.6**
e) Research, Monitoring, Species and Habitat Conservation and Management	Vehicle & POL (Four-wheelers)	15.0	15.8	16.5	17.4	18.2	82.9
	Vehicle & POL (Boat surveys)	54.0	56.7	59.5	62.5	65.6	298.4
	POL (Aerial surveys)	120.0	0.0	0.0	0.0	0.0	120.0
	Base Camp Establishment and Maintenance	6.6	3.9	4.1	4.3	4.5	23.4
	Travel & Accommodation	6.0	8.0	8.4	8.8	9.3	40.5
	Satellite telemetry	0.0	0.0	9.0	3.0	3.0	15.0
	Field/lab equipment & accessories	9.8	1.0	1.0	1.0	1.0	13.8
	Underwater &Onboard Monitoring Equipment	58.0	5.0	2.0	2.0	2.0	69.0
	Unmanned Aerial Vehicles / Drones	0.0	66.0	3.0	3.0	3.0	75.0
	Seagrass and benthic species monitoring	1.0	3.5	3.5	3.5	3.5	15.0
	Research/Conservation Genetics laboratory (genetics/pollutants) part cost	55.0	10.0	10.0	10.0	10.0	95.0
	Contingencies & Miscellaneous	2.0	3.0	3.0	3.0	3.0	14.0
Total Cost of Research, Monitoring and Conservation Management		**327.4**	**172.9**	**120.1**	**118.5**	**123.1**	**862.0**
GRAND TOTAL		**517.4**	**400.9**	**388.4**	**513.9**	**537.4**	**2358.0**

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Annexure II

Budget Summary

Activity	Amount (in Lakh rupees)					
	Yr1	Yr2	Yr3	Yr4	Yr5	Total
Manpower Engagement	64.0	64.0	70.4	77.4	85.1	360.9
Capacity Building and Awareness	51.0	79.6	108.5	92.7	97.1	428.9
Participatory Management	75.0	79.5	84.5	89.9	95.9	424.7
Marine Mammal Rescue and Rehabilitation Facility	0.0	5.0	5.0	135.4	136.2	281.6
Research, Monitoring and Conservation Management	327.4	172.9	120.1	118.5	123.1	862.0
GRAND TOTAL	517.4	400.9	388.4	513.9	537.4	2358.0