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Baseline Studies of Biological Environment in EIA Project: Strategies and Examples

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Abstract

Baseline studies are the most commonly recognized element of Environmental Impact Assessment. The term usually refers to the collection of background information on the environmental setting for a proposed development project and it is normally one of the first activities undertaken in an EIA. Present paper deals with baseline studies for biological environment that are pre-requisite for the preparation of EIA report.

Kew Words: EIA, baseline studies, conservation

Introduction

The Indian subcontinent is one of the most fascinating ecological and geographical regions in the world.Here lies the nearly rainless desert of Thar and the rainiest place on earth-Cherrapunjee; the hot, salty Rann of Kutch and the permanently snow-bound peaks of the Himalayas; the wet coastal regions ofKerala and the islands of Andamans and Nicobar; the great lake of Chilka and the river system of Ganga-Brahmaputra.

This variety of ecological condition sustains a tremendous amount of diverse life forms. About 15000 species of plants (out of a world total of 250000) and 75000 animal species (out of a world total of 1.5 million) have been described from India. On two percent of the world's landmass, India possesses around five percent of the known living organisms on earth. The plants and animals provide food, clothing, medicines, raw materials and all other human needs including aesthetic pleasure and a livable atmosphere.

Man's dependence on the environment is greater than that of other organisms because in the pursuit of progress, greater comforts and security, he consumes larger amount of materials and energy than does any other organism. The proper management of the human use of living resources, i.e., conservation has, therefore, become very important today. Conservation of living resources has three specific objectives.

- To maintain essential ecological processes and life-supporting systems
- To preserve the diversity of species and the genetic resources-the absence of which in the long run threatens human survival itself
- To ensure sustainable utilization of natural resources, i.e. which assures survival of all species including human beings

The threat posed by continuing environmental degradation is no longer hypothetical, and it has serious economic and social implications for the future. In view of this, various steps have been taken in India, which is one of the few nations in the world to have given priority to environmental protection, not only in terms of its ancient heritage, but also in enshrining environmental concerns in the Directive Principles of Constitution and in Governmental actions. Environmental Impact Assessment (EIA) of developmental projects was first introduced in India in 1977-78 and Ministry of Environment and Forest (MOEF) is the nodal agency for EIA.

The MOEF published guidelines for preparation of EIA Statement along with questionnaires and checklists for industrial projects. Project proponents are required to provide relevant information as indicated in the guidelines along with the Environmental Impact Assessment Statement/Environmental Management Plan (EMP). The technical experts of MOEF make a preliminary scrutiny of the project proposals. After ensuring that the main aspects are covered, EIA reports are placed before the Appraisal Committees of Experts. The environmental clearance to development projects is subject to implementation of stipulated safeguards under the provisions of Environment (Protection) Act 1986, Forest (conservation) Act 1980, and other rules and regulations in force. The MOEF on January 27, 1993, brought out a draft notification under the Environment (Protection) Act 1986 making environmental clearance mandatory for expansion or modernization of any activity, if pollution load is

to exceed existing levels, and also for new projects listed in Schedule I of the notification. The notification was subsequently modified in May 1994.

Ecological Category

Species and population: Species and population are the basis for the ecological world, and their existence can be greatly influenced by changes in their environments. Care should be taken to describe those species and populations that can be identified. However, many species cannot be identified and how they will be affected by environmental changes is unknown. Further, certain species are used as indicators of healthy and unhealthy human environments as well as the status of the general environments (Table 1). These should be discussed in detail. Typical consideration might be

- With the removal of natural feeding sites, is the animal life of the area adversely affected?
- Does the effluent of the proposed project suggest impairment to aquatic life?
- Are the flora and fauna of the region significantly affected?

Communities and habitats: A group of species is a community. A habitat is the environment of a community. The existence of a variety of species and communities living together is the result of numerous and complex interaction. Major habitats include streams, lakes, estuaries, swamps, deserts, marshlands, forests, all components of some river basins etc. Different temperatures and overall climate affect different habitats for the various trees. Industrial development may physically destroy vegetation and wildlife by altering or destroying habitats. The effects may be both on the site itself as a result of construction and in the surroundings as a result of pollution from the development and secondary effects in the community. The impact of development on the flora and fauna (aquatic and terrestrial) should be evaluated by site surveys before and after development to determine the diversity and abundance of major species at various times of the year. To inventory, the populations within species, number of different species and their spread over should be noted. Typical considerations might be:

- Is the proposed action going to result in the destruction of rare and endangered species habitat?
- Are project-induced population shifts eliminating important biological communities of the local ecosystem?
- Are soil communities destroyed due to leachate at waste disposal site?

Ecosystem: An ecosystem is the entire natural life system of a local environment. River basins, forests and plains are typical natural systems in which ecosystems function. The fundamentals of most ecosystems are known, but data are lacking on the numerous processes and interactions that occur. Thus, in the ecosystem analysis, assumptions are made and the justifications for such assumptions are described.

Biodiversity: The term 'biodiversity' is commonly used to describe the number, variety and variability of living organisms. Perhaps because the living world is most widely considered in terms of species, biodiversity is very commonly used as a synonym of species diversity, in particular of 'species richness' which is the number of species in a site or habitat. Conservation of biological diversity is a form of natural resources management, which has as its primary goal maintaining the long-term potential of world biological resources to meet the needs and aspirations of future generations- a fundamental principle of sustainable development.

Ideally, any implications for biological diversity will be among the major issues identified during the screening of proposed project. A simple checklist to assist in early identification of biological diversity issues is provided below:

- Identify the specific types of ecosystem the proposed projects will affect (tropical forest, wet land etc.). Are any of them wild lands of special concern or designated natural sites of national or international importance?
- What are biological features of the ecosystems; e.g. habitat for endangered species, or only breeding and nesting area for a particular species.
- Determine the general nature of the project's impact on ecosystems, e.g. deforestation, flooding, draining, changing hydrological regime, facilitating human access etc.
- Assess the significance of likely negative impacts relative to
    - Total area of ecosystem type in region and/or country (e.g. project will destroy approx. 10% of nations remaining lowland forest)

- Cumulative effects and trends for ecosystem type (e.g. tidal wetlands area is being lost in the country at an annual rate of 3% a year; this project and two other harbor facilities projects planned for the coastal zone will involve a total of 6% of the remaining area)

Table 1. Usefulness of various Taxonomic groups as biological indicator

Group	Distribution (Species Patterns)	Taxonomy	Working level	Ease	Sampling	Movement	Organics/ Nutrients	Metals	General Water Chemistry	Interpretative Strength
Bacteria	Cosmopolitan	Incomplete	Genus, Species	±	Descriptive, Statistical	Generally Stationary	✓		✓	Limited by sampling or analysis difficulties, high indicator strength
Fungi	Cosmopolitan	Incomplete	Genus	-	Descriptive	Generally Stationary	✓			Limited by sampling or analysis difficulties
Protozoa	Cosmopolitan	Complete	Species	+	Descriptive	Generally Stationary	✓	✓	✓	Ecological relationships poorly understood, saprobic importance
Algae										
Periphyton	Cosmopolitan	Approximately complete	Species	±	Descriptive, approximately statistical	Generally Stationary	∽	✓	✓	Good indication of water chemistry and enrichment
Phytoplankton	Cosmopolitan	Approximately complete	Species	±	Descriptive, approximately statistical	Mobile	∽	✓	✓	Good indication of water chemistry and enrichment
Macrophytes	Geographic regions	Complete	Species	-SS	Descriptive, approximately statistical	Sessile			✓	Limited by sampling or analysis difficulties
Invertebrates										
Zooplankton	Cosmopolitan, Geographic regions	Approximately complete	Genus	-	Descriptive. Approximately statistical	Mobile		✓	✓	Limited by sampling or analysis difficulties, Ecological relationship poorly understood-high value in lentic ecosystems, early trophic effects
Insects	Geographic Regions limited	Incomplete	Genus. Family	-	Descriptive	Sessile		✓	✓	Ecological relationships
Molluscs	Geographic Regions limited	Approximately complete	Species	+	Descriptive, Statistical	Sessile	∽		✓	Site specific indicators
Worms	Cosmopolitan	Incomplete	Species	-	Descriptive				✓	
Vertebrates										
Fish	Geographic regions limited	Incomplete (Life stage limited)	Species	+	Descriptive	Mobile	✓	✓	✓	Limited by sampling difficulties and early life stage identification
Mammals	Geographic regions limited	Complete		+	Descriptive	Mobile				

+ : relative ease of identification; - : difficult identification; ± group or life stage difficult identification; -SS: difficult identification is season specific; ✓ :taxa used to indicate pollution effects;
∽ : mixed, group or life stage specific

Water Environment

Water is one of the necessities to life, as we know it. All flora and fauna life cycles use it and generate wastes. These wastes have now begun to inhibit the use of water for its intended purpose. Thus, water of a region must be assessed as to its quality, quantity and availability. Before conducting a water quality impact assessment, all applicable water quality criteria and standards must be known. 'Water quality criteria' as distinguished from standards, are defined as the levels of specific concentrations of constituents that are expected, if not exceeded, to assure the suitability of water for specific uses. However, barring microbiological parameters, specific standard levels of different biota are not recommended under surface water quality criteria in India.

The water quality team must scan the environment in the area of the proposed project and review the characteristics of the project. The objective is to determine possible water quality impacts, which might result from the project, and to identify sensitive or critical environmental areas. Surface and groundwater resources should be identified and their general biological characteristics should be evaluated. The plan should address

- Location of sampling stations.
- Parameters to be analysed and identification of sampling equipments.
- Time schedules, including time of day, time of year and frequency.
- Method of data collection.
- Sample handling, preservation and transport before analysis.

Studies should lead to selection of certain biological indicators that will enable the assessment team to adequately describe the environment. Sensitive organisms must be described in detail, particularly if the proposed action could have an impact upon such organisms. The major parameters need to be taken care are cited below.

Primary productivity: It is dependent on the photosynthesis of green plants principally of phytoplankton in all water bodies including sea. Light and dark bottle technique as described in standard can be applied.

Chlorophyll: Different types of pigments are found in algae, which are classified in to chlorophyll –a, chlorophyll –b, chlorophyll –c, xanthophylls and beta carotene. Among these, chlorophyll –a and beta carotenes are the principal pigments which are present in all classes of algae. Extractions of phytoplankton pigments in acetone and their quantification is considered as a standard and valid method for assessing the phytoplankton standing crop of any ecosystem.

Enumeration: Each phytoplankton, zooplankton, macrobenthos, meiobenthos and other nekton species in aquatic bodies should be assessed through count at unit area/volume.

Biomass: Biomass is the quantitative estimation of the total mass of living organisms within a given area or volume. Direct weight of comparatively larger species or chlorophyll (for algae) /carbon/cell volume method for smaller flora/fauna can be adopted.

Diversity Index: Following are the diversity indexes

a) Shannon Weiner Diversity Index (d) – it is a measure of diversity which takes into account the total count and individual count in a sample and is expressed as

$$d = -\Sigma(ni/N)\ Log_2^{(ni/N)}$$

where,
ni=number of individuals of each species,
N=total number of individuals of all species

b) Diversity index (D) of Margalef

$$D = \frac{S-1}{Log_e N}$$

Where, S=total number of individuals

c) Equitability index (Pielou) (E)
$E=d/\log_2 S$

where,
d=Shannon Weiner diversity index,
S=number of species in the community

Similarity index: This index (S) is necessary while comparing similarity or dissimilarity of communities among different sampling points

$S=2C/(A+B)$

where,
C=number of species in sample common to both samples
A=number of species in sample A
B=number of species in sample B

Fisheries: Different varieties of fishes comprise as principal community of any aquatic ecosystem. Therefore, detailed investigations on fisheries are necessary in any EIA study. The investigator should first be acquainted with the following aspects.

- What is the current fish community structure (biological integrity), and does it indicate poor or good fishery health?
- Are the fish diseased, parasitized, or deformed? If so, to what extent?
- Do the fish contains toxic substance? If so, to what extent?
- What are the distribution and extent of the sport and commercial fishes?
- Is the growth of the fish is in accordance to normal enlargement of both length and weight?
- Do the fish mature and breed in concerned water body?

The studies should also cover different fishing instruments (crafts and gears), harvest of various species, feeding habits of the organisms, condition factors, fecundity, food values, fishermen's social welfare etc.

Food chain: The essential components of a grazing food chain are the following fivetrophic levels

- Primary producers comprising phytoplankton
- Herbivores (including herbivorous fish), primarily includes zooplankton which graze upon phytoplankton
- First stage carnivores, comprising small carnivorous fish, insects, mollusks etc.
- Second stage carnivores comprising larger predatory fish which prey upon smaller carnivorous fish, and
- Third stage carnivores consisting of the top ranking larger predatory fish and birds.

Basically the food chain holds true in all waters fresh, brackish and salty waters of the seas and oceans.

Trophic structure and ecology pyramids: The occurrence of food chain phenomenon in nature results in a tropic stratification of biotic communities in aquatic ecosystems. Each of the stage of the food chain is called trophic level. The trophic structure of the ecosystem can be rendered into pyramid that can be expressed in the form of number, biomass or energy.

Terrestrial Environment

Assessment of the biological portion of the terrestrial environments must include what are present, their values and response to impacts. Various methods are available to describe the natural community and its components. The assessment should provide a description of community uniqueness, the dominant species, and an evaluation

of rare and endangered species. Further, the assessment should consider the vulnerability to and the outcome of various human impacts. The biologist should obtain answers to a series of questions as mentioned below before the actual biotic assessment study begins

- What is the geographic size of the proposed project site?
- What part of the site is involved in the proposed projects?
- What is the type of project?
- Is the project to be short-term final or long-term incremental?
- If long-term incremental, is the biotic assessment to be done in increments or at one time?
- What is the biotic character of the part of the site involved?
- How will the project influence the plants?
- How will the project influence the animals?
- How will the project influence the ecology of the various habitats?
- What information exists on the biota of the area?

Baseline studies should list the dominant plants and animals species found on the proposed site, as well as possible rare and endangered species. These should be discussed in a regional context as to their uniqueness or commonness. Sensitive or fragile habitats and their associated species should be studied and described in greater detail in order to establish baseline data that can be used to detect unforeseen projects impacts.

Some biotic areas are sufficiently researched so that secondary source can be used rather than detailed on-site studies. Although such secondary sources may have a cost advantage, they should be used with caution since biological communities change continuously as does the status of certain species.

Plant survey: Vegetation can be assessed in several descriptive ways. A species list includes both common and scientific names of the plants found or suspected to occur in the study area. The list is developed by site visits and by consulting published literature. Secondary sources must be referenced. Since the species list does not convey the relation between plants and the environment, it should be appended in the report.

The common tools employed in vegetation assessment are abundance scale (Table 2) based on species cover, importance value index (IVI) based on relative density, relative dominance and relative frequency, diversity indices as described under aquatic environment assessment, biomass, economics etc. Common measures of importance of terrestrial plant species in a community are depicted in Table 3. The following steps are measured for calculating IVI of plant species.

Density = No of species A/ area sampled

Dominance = Total cover or basal area of species A/ area sampled

Frequency = Number of plots in which species A occurs/ total number of plots sampled

Relative density = (density of species A/ total density of all species) * 100

Relative dominance = (dominance of species A/ total dominance of all species) * 100

Relative frequency = (frequency of species A/ total frequency of all species) * 100

Importance value index = (relative density + relative dominance + relative frequency)/ 3

Larger quadrates, transects, line intercepts and plotless methods are used to evaluate perennial shrub or tree community types. Transects may be of any desired dimension, but usually 10 or 100 times as long as wide. One meter is a convenient width since it allows for accurate accounting of each plant. Line intercepts are linear plots usually 10 to 100 meters in length. Under point quarter plotess method, a series of points randomly determined. Each point is divided into four 90° quadrants. The tree at each quadrant is identified, its distance from the point is measured, and its basal area is determined. Minimums of 50 such point tallies are generally taken.

Table 2. The Braun-Blanquet and Domin Scales for Cover Abundance

Braun-Blanquet		Domin	
r one or a few individuals		+	one individual
+ ocassional and less than 5 % of total plot area		1	rare
1 abundant and with very low cover, or less abundant but with high cover; in any case less than 5 % cover of total plot area		2	sparse
2 very abundant and less than 5 % cover, or 5-25 % cover of total plot area		3	less than 5 % frequent
2 m very abundant		4	5-10 %
2a 5-12.5 % cover, irrespective of individuals		5	11-25 %
2b 12.5 – 25 % cover, irrespective of number of individuals		6	26-33 %
3 25 – 50 % cover of total plot area, irrespective of number of individuals		7	34 – 50 %
4 50 – 75 % cover of total plot area, irrespective of number of individuals		8	51 – 75 %
5 75 – 100 % cover of total plot area, irrespective of individuals		9	76-90 %
		10	91–100 %
Sociability			
1. Growing solitary, singly			
2. Growing in small groups of a fiew individuals, or in small tussocks			
3. Growing in small patches, cushins, or large tssocks; hummock builders			
4. Growing in extensive patches, carpets, or broken mats			
5. Growing in great crowds of extensive mats completely covering the whole plot area; mostlypur populations			
Phenophase			
v. (Vegetation)			
fl. (flowers)			
fr. (Fruits)			
e.g. Scirpus maritime 2.3.v (cover sociability phenophase)			

Table 3. Common measures of importance of terrestrial plant species in a community

Important Measures	Definition
Density	Number of individuals per unit area
Foliar cover	Percent of ground surface covered by leaves
Individual overlay	Sum of cover percent counting each individual's canopy separately (can exceed 100 %)
Projective foliar cover	Percent of ground surface covered one or more times by leaves of the species (can not exceed 100 %)
Leaf area index	Average number leaves stacked above any point on the ground
Basal area	Cross sectional area of tree trunks at breast height (1.37 m)
Frequency	Percent of small sample plots within a study site in which a species occur
Constancy	Percent of large study sites of the same size, out of the total sampled, in which the species occurs
Presence	Percent of large study sites in which a species occurs when plots are not of the same size
Net primary production	Net increase in biomass per unit time before herbivory or decay

Animal survey: The animal life (fauna) of an area is dependent upon the vegetation, and there are countless relationships between the species composing an animal community. The choice of animal survey method varies with the extent and purpose of the study and with the composition of the animal community involved, such as insects, birds and mammals.

Animal community can be assessed by observing the fauna directly. A species list should be prepared by walking through the area. A trained biologist can determine the presence of certain animal species by recognizing animal signs, such as tracks, scats, bones etc. published lists and description of animal species should be consulted.

Insects and other arthropods require aerial and sweep nets for collection during flying condition in day. Birds are best studied by direct observation with the help of binoculars. Bird calls are meaningful only to a well-trained bird watchers. Pre-selecting routes to be walked through the study site can systematize the survey of birds. These routes of a given distance, time, direction and in representative habitats, make it possible to quantify somewhat the abundance and range of each species. Roadside counts along roads and highways and also along existing or proposed power-line, pipelines, railroads and other right of ways are used for determining count indices. For example, a count would be made at ½- km intervals for a total distance of 5 km. The data are expressed as a census index defined by

Census index = N/D

Where,
N=Number of individuals of each species seen
D=Distance in km traveled

Mammals and other vertebrates such as reptiles and amphibians can be studied directly by observation or collection, or indirectly through their tracks, homes, or sound.

Rare and Endangered Flora and Fauna

Botanical survey of India has published a list of 134 most threatened plant species, of which 99 are in the Himalayas and the northeast. Twenty eight species of orchids are endangered. Northeast India has the third largest resources of plants in the world for any area of similar size. About 50 percent of the total flora of India comes from this region.

The first comprehensive listing of endangered wild life species in India was complied in the wildlife (protection) Act, 1972 which provides for protection of threatened faunal species from indiscriminate hunting. Schedule I of the Act identifies 77 mammals, 25 reptiles, amphibians, 51 birds and 130 crustaceans and insects as rare and highly endangered species, which are totally protected throughout the land.

Wildlife conservation is a total concept involving animals, plants, microorganisms and soil, and also others physical elements of environment on which they live and depend. In view of this, baseline studies under EIA should cover detailed list of the animals and plants, their biology, habitat, behaviour (feeding, migration etc. of animals) and features.

Base Line Studies on Aquatic Environment : A Case Study

The comprehensive work carried out during 1991-92 for a project of Thermal Power Station in West Coast of India has been briefed below:

This site was selected for the installation of a 500 MW coal based thermal power station, which is surrounded by three creeks on three sides. The comprehensive studies dealt with seasonal (summer, post monsoon and winter) monitoring of the creeks, development of food webtrophic levels and pyramids as well as assessment of mangroves in surrounding wet lands based on reconnaissance survey, 12 sampling points and frequency of samples were selected.

Primary producer: In situ primary productivity experiments following dark and light bottle methods were carried out on two consecutive days in each season at different sampling points. Gross primary productivity (0.0867, 0.195 and 0.208 gm Cm^{-2} day^{-1} during summer, post monsoon and winter respectively) of the creek waters appeared to be negligible. This has further been supported by poor chlorophyll of the algae contents. While total algal population varied between 380 and 5000 cells per 100 ml, bacillariophyceae represented as principal group. In general, variations in total counts and composition of phytoplankton recorded during high tide and low tide in three seasons were not remarkable. As compared to mouth of creek (2.4-3.0), SW diversity indices varied widely (1.31-3.43) among remaining samples of the creeks. While applying similarity indices, phytoplankton species composition indicated higher similarity among different samples of high tide in summer and of low tide in winter seasons. Each algal species was assessed further on the basis of density, biomass and frequency of occurrence computed together as absolute importance value. Among 29 species of phytoplankton,

N.closterium, *Coccosphere* sp. and *Navicula* sp. scored highest importance values (absolute) in summer, post monsoon and winter seasons respectively. The habitat, based on preference and availability of phytoplankton was evaluated through importance value (habitat) and y-diversity. It has been estimated that *N. closterium* followed by *Navicula* sp., *Coccosphere* sp., *Oscillatoria* sp. etc. were the most acceptable phytoplankton in the creek habitat. Presence of species like *Rhizosolenia* sp., *Mougeotia* sp., *Gomphonema* sp. was susceptible in the area.

Zooplankton: Zooplankton were represented by 89 species from 28 major taxa, of which copepoda dominated in all 62 samples analysed. Total count was varied among seasons, tides, banks, depth and time of sample collection. Average zooplankton count in high tide sample was less that of low tide sample. Like phytoplankton, SW diversity indices of zooplankton fluctuated widely (0.39 to 3.55) in creeks as compared to open sea (0.65 to 2.27). Moderate similarities of zooplankton species among different sampling points have been recorded. While assessing importance of individual zooplankton, it appeared that barring a few, namely copepod nauplius, *Oithona* sp., *Paracalanus* sp., *Hemisiriella* sp. and *Acartia* sp., zooplankton of the creeks either did not appear in all the three seasons or their density, frequency and biomass were of poor significance when available throughout the year. Four plankters, namely puffer fish larva, *Liriope* sp., *Planaxis* sp. and *Oikopleura* sp. emerged as most sensitive organism in the creeks.

Benthos: Benthic fauna was segregated to meio- and macrobenthos, which were represented by 20 taxonomic groups. Density of benthos varied among banks and sampling points. Based on diversity and density, nematodes represented as the most dominant meiobenthos in summer but foraminiferas outnumbered others in post monsoon and winter seasons. SW diversity indices of benthic organisms varied between 0.92 and 4.23. However, taxonomic composition indicated higher percentage of dissimilarity among different locations. Based on concept that meiobenthos are 5 times more metabolically active than macrobenthos, metabolic indices (MI) of benthos at different sampling points have been estimated.

Fisheries: In order to have baseline status of fisheries during precommissioning phase of the thermal power station, fish and fisheries of the creeks have been studied in detail with special reference to crafts and gears used, fishing, harvest of fin and shell fish, diversity index, importance value of each species, condition factor, length-weight relationship, feeding habit, gonosomatic index, fecundity, habitat evaluation, heavy metal contamination, calorific value of edible tissues, fish farms and fisheries co- operative societies. All these parameters are variable with altered environment condition and the data generated will be useful for comparison with those of post commissioning phase.

Test netting by bag net was employed during different tides at different sampling stations. Harvest with respect to diverse fish species and total weight was generally more in between low tide and high creeks along with water current. However, remarkable size-related catch among sampling points/ tides was not recorded. Altogether 82 varieties of fishes were harvested.

Prawns, which contributed 8.16, 2.56 and 2.56 percent of total harvest during summer, post monsoon and winter seasons respectively were represented by 12 species. In general respectively were represented by 12 species. In general, harvested penaeid prawns were comparatively larger in size from those of nonpenaeids. The survey indicated that nonpenaeids do enter the creeks in between low tide and high tide and penaeide, which generally migrate from sea to creeks at juvenile stages, prefer creek region and was trapped while moving towards sea in between high tide and low tide.

Besides fish and prawns, particulars of other macrofauna including trash fish were investigated. Cephalopods, represented by *Loligo* sp. and *Octopus* sp., contributed only 0.40 and 1.23 percent respectively of total catch in summer. The values decreased marginally in winters but increased substantially in post monsoon seasons.Cuttle fish (*Sepia* sp.) were harvested only in post monsoon season. However, a sizable portion (33, 9 and 82 percent in summer, post monsoon and winters seasons respectively) of total harvest was shared by relatively little fin and shellfishes, called trash fish. Other macrofauna captured by fishing nets were crabs, squilla, jellyfish and sea snakes.

Diversity indices for fish and prawn species have been determined on the basis of number and weight. Generally index values for fishes were more from those of prawns because of diverse species composition of the former. Attempt was also made to estimate composite index of community well being (I_{WB}), often followed for water bodies of U.S, for fish and prawn of the creeks. I_{WB} values estimated for the creeks were comparatively more

from those of Wabash River, Indiana, determined during 1968-81. Importance values of all fish and prawn species were assessed. The fish *Lepturacanthus savala* followed by *Harpodon nehereus* and the prawn *Metapenaeus brevicornis* followed by *Metapenaeus monoceros* emerged as most important species in respective groups. On the other hand, *Ambassis commersonii* followed by *Cynoglossus lingua* and *Hippolysmata vittata* followed by *Penaeus monodon* were the least important fish and prawn species respectively. Condition factor (K) and length-weigth relationship followed the equation "W=a Ln" are good indicators of change in habitat, season, sex and health of fish and prawn species. Baseline conditions (K) of 82 varieties of fishes and L-W regression equations of major fish and prawn harvested during three seasons were studied. The varieties with isometric and allometric growth have also been identified. Feeding habits of the fish and prawn of study area have been studied critically with special reference to morphology of alimentary canal, stomach volume and gut contents. Postmortem examinations revealed that most of the fishes were voracious eaters with 3 to 11 percent of total body weight as stomach contents. Gonosomatic index (GSI), a factor of gonad, was studied because of its variable nature with altered abiotic characteristics of the environment. GSI were maximum for the fishes *B. dussumieri* and prawn *H. ensirostris*. Microscopic examination of eggs revealed that majority of the fish and prawn varieties were not in sexually matured stage.

The preference of the creek habitat by the fish and prawn was evaluated through density and frequently in catch. This habitat was mostly preferred by fish *L. savala* followed by *H. nehereus*, *P. elongata*, *S. biauritus* etc. and prawn *M. brevicornis* followed by *M. monoceros*, *P. sculptilis* etc. *A. commersonii* and *H. vittata* were the most sensitive fish and prawn respectively of this habitat.

Selective heavy metals (Cd, Cr, Cu, Pb, Fe, Zn, Mn and Ni) were analysed from edible tissues of certain fin and shell fishes of the creeks. The order of metal accumulation was Fe>Zn>Mn>Cr>Cu>Pb>Ni>Cd. However, metal accumulations in fishes and prawns under study was less while comparing to those published in literature from different regions of oceans. Moisture contents and calorific values of selective fish and prawn were estimated. The nutritive calories for fish muscles varied between 3.79 and 4.85, 4.20 and 5.40 cal gm-1 dry wt in summer and post monsoon seasons respectively. The same for prawn fluctuated from 4.07 to 5.06 gm-1 dry wt in summer.

Avifauna: Studies on shore birds which feed mostly on fish, invertebrates, offal etc., at three regions of the creek indicated that Black-headed gull, Little stint and Indian reef heron were dominant at three different creeks. Altogether 17 species of avifauna were recorded, of which White bellied sea eagle is endangered species.

Tropic levels: Tropic status of the ecosystem has been evaluated on the basis of feeding habits of the organisms. Herbivorous zooplankton (consumer 1) indiscriminately ingests phytoplankton, the producer (P) and organic matter suspended in seawater. The third trophic level (C2) in creeks was mostly occupied by macroplankton (chaetognaths, polychaete worms, larvae and adult of various crustaceans and gastropods etc.) as well as macrophagous nekton (various decapods and plankton feeding fish). Trophic levels IV (C3) and V (C4) of this region were occupied by predator fish, cephalopods and shore birds. While computing biomass of each trophic level, semi-alternating pattern of pyramids were obtained in all the three seasons. The ecological efficiencies (percentage biomass transfer in succeeding trophic levels) of the region measured were 1584, 486, 13 and 10 percent at C1 through C4 respectively during summer. The same for other seasons in aforementioned order were estimated as 3796, 127, 38 and 14 (post monsoon) and 11358, 57, 8 and 18 (winter). In food chain trophic level, meiobenthos (C1), which contributed about 25 percent of total fauna, had a significant role. Since concentration of producer (P) was poor in creeks, detritus was the principle source of food for meiobenthos.

Other aspects: The creek water exhibited negligible number of coliform and faecal coliform group of organisms indicating marginal contamination of faecal pollution. Mangroves and halophytes around the creeks have been studied in detail. Among the vegetation *Avicennia marina* was the most important plant. Plantation of Mangroves in barren areas by the project proponent has been recorded.

Base Line Studies on Terrestrial Environment : A Case Study

The base line studies carried out during 1990 –91 towards terrestrial environment under a project pertaining to construction of a dam on a river have been summarized below. The project proponent proposed to develop additional source of water by creating an impoundage through the construction of a dam in between existing upper and lower dams on a river

Vegetation Study: Six forests from submergence and catchment areas were selected within 15 km radius at different directions around proposed dam site. Observations were made at each sampling point pertaining to girth, perimeter, tree height, canopy cover of the trees, types of shrubs, herbs etc. Information towards list of vegetation, forest nursery etc. was collected from concerned forest department and botanical survey of India. Reserved forests on upstream (E) and downstream (f) sides of the existing dam at downstream of the river were considered as reference points.

To sample the vegetations, random plotless sampling methods were adopted. Sampling locations were randomly selected at hill tops, on the slopes and in the valleys between hills. The following six associations of trees were observed in study area.

- Teak- ain- kuda- karvand
- Teak- khair-kuda-takla
- Teak-dhavada-kuda-takla
- Ain-khair-koshimb-karvand
- Kakad-shemat-kuda-takla
- Ain-bonda

The common plants under top canopy trees, second storey trees,s hrubs, herbs and climbers were recorded. Information towards different injuries like setting fire, illegal cutting of trees, removal of leaf litters etc. was collected. Among the six forests, surveyed, the forestA exhibited maximum diversity index with richest floristic distribution. Barring forest B and F, *Tectona grandis* emerged as the most dominant species in the forests. Details of floristics, similarity indices, equitability indices, IVI, canopy, S-W diversity indices etc. have been evaluated. While Table 4 depicts different features of the six forests, IVI of various tree species of a representative forest (B) are presented in Table 5. Similarity indices indicated maximum resemblance among the trees between upstream and downstream forests of existing dam.

Table 4. Diversity and features of tree species in different forests around proposed dam site

Sr. No	Parameters	Forests					
		A	B	C	D	E	F
1.	Diversity index	3.610	2.730	2.160	3.00	3.200	3.490
2.	Equitability	0.905	0.864	0.930	1.00	0.966	0.896
3.	Density (ha^{-1})	254.390	60.000	51.020	21.12	57.470	117.450
4.	Most important tree	*Tectona grandis*	*Anogeissus latifolia*	*Tectona grandis*	*Tectona grandis*	*Terminalia tomentosa*	*Tectona grandis*
5.	Average height (m)	5.610	5.090	6.370	5.870	7.650	10.360
6.	Average cover area per plant (m^2)	23.000	29.000	15.110	33.110	27.180	38.800
7.	Source* of cover abundance class	4.000	2 b	2 a	2 a	2 b	3.000

The source 2a, 2b. 3 and 4 indicate total cover of 5 –12.5, 12.5-25, 25-50 and 50-75 % respectively of Braun-Blanquet scale.

Table 5. Structure of forest: B

Sr. No.	Name of Species	Density Tree/ ha	Relative density (%)	Relative dominance (%)	Relative frequency (%)	Impornace value index (%)
1.	*Carissa caranda*	3.75	6.25	0.59	7.69	4.84
2.	*Tectona grandis*	3.75	6.25	4.87	7.69	6.27
3.	*Anogessus latifolia*	22.50	37.5	18.83	30.77	29.03
4.	*Bridelia retusa*	3.75	6.25	2.78	7.69	5.57
5.	*Mangifera indica*	11.25	18.75	42.43	15.38	25.52
6.	*Terminalia arjuna*	3.75	6.25	18.20	7.69	10.71
7.	*Bombax malabarica*	3.75	6.25	1.22	7.69	5.05
8.	*Lagerstrocemia parviflora*	3.75	6.25	6.20	7.69	6.71
9.	*Grewia latifolia*	3.75	6.25	4.87	7.69	6.27

Fauna Assessment: Field studies were carried out on different routes at three directions mentioned below:

Route 1 : 9 km
Route 2 : 10 km
Route 3 : 16 km

Road side counts were made preferring fixed-width transects. Community studies were carried out in which the census of a mixed population is intended for comparison with similar lists from other localities. The data were subjected to detailed analysis following dominance, census, species, richness, species diversity and similarity indices.

Dominance index $D = (ni/N) * 100$

Where,
ni=count of individual species recorded
N=total count of all species

Census index $C = (ni/M)$

Where,
ni= count of individual species recorded
M=area covered

Species richness index

It is expressed as total number of species recorded at each sampling route.

Diverse groups of birds representing 30 species were recorded in study area. Higher varieties of avifauna as encountered along route 2 might be attributed to vast area of forest, human inhabitation and agricultural fields. Studies on percent dominance and census index revealed that values were more for houses swift along routes 1 and 3 and for domestic hen along route 2. It was observed that the values did not differ remarkably, when distribution patterns of the birds, present along with different routes, were compared through similarity indices. Similarity indices between 1-2, 2-3 and 1-3 routes were 0.59, 0.56 and 0.60 respectively indicating moderately similar types of birds on different routes. Maximum and minimum diversity indices were recorded along routes 2 (4.775) and 1 (3.450) respectively. Distribution of animals within specific area (census index) differed widely along routes 2 and 3. Lowest census index along route 3 might be attributed to less number of villages and absence of agricultural fields.

The study area is having one game sanctuary. The details of area, list of animals, their census, water holes, feeding habits, movements and behavior were recorded from respective Government organizations and field visits. The animals belonged to schedules I (absolute protection), II (special game), III (big game) and IV (small game) were recorded.