REPORT

Editors' Note: The introductory material for every BCPP CAMP Report is the same. Therefore we have given it in a smaller typestyle to fit in one page. Readers who are familiar with these Reports can go directly to the section on the following page which deals specifically with Indian Mangrove Ecosystem.

Convention on Biological Diversity

The Convention on Biological Diversity adopted in Nairobi in its provisions are expressed as g May 1992 and signed by more than 150 states in June 1992 at Rio de Janeiro, came into force officially in December 1993. The Convention is a "framework agreement" in that oals and policies (as opposed to "obligations"), leaving the implementation of its provisions up to individual parties (the states) at the national level. In the Convention, the importance of non-governmental organisations in implementing the provisions was specifically mentioned.

Articles in the Convention cover objectives, terminology, principles, legislation, cooperation and strategy as applied to various issues and methodology. One of the very basic methods of organising conservation action is prioritisation. Article 7 of the Convention deals with Identification and Monitoring, calling on parties to identify components of biological diversity important for its conservation and sustainable use. Components of an "indicative list" include:

** Ecosystems and habitats*
** Species and communities, and*
** Described genomes and genes of social, scientific and economic value.*

Knowledge of species and communities can reveal crucial facts necessary to the management of ecosystems and habitats as well as to the identification of important genomes and genes. Identification, listing and prioritisation of species are one of the important tasks in conservation. In India, it is well known by biologists across many taxon groups that species information has many gaps. In many instances, the species has not been surveyed or studied since its description, perhaps in the 18th or 19th century. Even species, which have been studied more recently in the 20th century, require constant attention due to the fact that the very fabric of the earth is changing so rapidly. It is common knowledge today that the ecosystems and habitats which sustain species are deteriorating exponentially as a result of population expansion, industrialisation, and the build-up of habits resulting from decades and centuries of thinking the Earth and its resources were unlimited. Awareness of this fact is, of course, the raison d'être for the Convention on Biological Diversity itself.

Biodiversity Conservation Prioritisation Project – Endangered Species Component

The Biodiversity Conservation Prioritisation Project (BCPP) is an attempt to amalgamate the knowledge of government, academics, enthusiasts, and other knowledgeable persons of India to meet obligations of the Convention on Biological Diversity. This Project was funded by the Biodiversity Support Program, a consortium of organisations, USAID, World Resources

Institute and the Nature Conservancy, and coordinated by World Wide Fund for Nature. It consists of three segments, sites, species and strategies for biodiversity conservation. The overall aim of the species segment is to list out species which need to be conserved for their biodiversity value in order of priority, under categories of medicinal and economic value, wild relatives of domesticated and cultivated species and other endangered fauna, flora and micro-organisms.

An Endangered Species Subgroup decided to use the IUCN criteria to assess the conservation status of a large part of Indian species diversity. A workshop "process" called the Conservation Assessment and Management Plan (CAMP) developed by the Conservation Breeding Specialist Group, SSC, IUCN was selected by the subgroup as the methodology to use for conducting the assessments. CBSG, India, a Regional Network of the Conservation Breeding Specialist Group was asked to conduct the "CAMP" workshops on the basis of their experience and expertise. The IUCN Red List criteria are central to the CAMP process.

IUCN Red List

Earlier efforts to monitor the earth's resources and activate conservation measures include the Red Data Books of IUCN, now called the World Conservation Union. The IUCN Red Data Books have provided a guide for species conservation status for the last three decades. A few years ago, it was felt that both the categories and methodology used by individuals compiling the Red Data Books needed review. Over a seven-year period, the IUCN Criteria for Endangerment used in compiling Red Data Books, were examined, revised, reviewed and improved over six different iterations. The present system, the IUCN Red List Categories, 1994, is more objective, numerate, and consistent for all groups. The revised IUCN Red List Categories provide a methodology for assessment and categorisation, which can be applied, to any group of organisms (except microorganisms). The revised IUCN Red List criteria is being used now by conservation actioners and scientists all over the world and is considered the best possible method available today for assessing the conservation status of species.

Conservation Assessment and Management Plan

One of the great difficulties of carrying out basic tasks such as identification and monitoring, creation of management and action plans and recovery programmes for species, is coordinating the great mass and variety of specialist knowledge and agency authority. Much time and energy is wasted in duplication of effort, territorial and ownership disputes, and inability to find and adhere to a common ground. The business community, realising the importance of effective communication and teamwork, has developed a broad spectrum of management strategies and tools which are used daily to manage time and human interaction. More and more, the conservation community is recognising the importance of using some of these tools to achieve their goals, rapidly and effectively. The Conservation Breeding Specialist Group (CBSG) of the Species Survival Commission of IUCN has pioneered the use of some these tools in well-planned strategic problem-solving and task -performance exercises. CBSG calls these exercises "processes" because — in the contemporary conservation scenario — nothing is static except the fact of change itself.

The Conservation Action and Management Plan Workshop was developed by CBSG for the purpose of prioritising species for conservation action including ex situ component. Over the last decade, CBSG has conducted dozens of CAMP workshops for literally hundreds of species, using (and thereby testing) the then current iteration of the IUCN Red List Categories as their basic methodology to glean a status ranking. The IUCN Red List guidelines and criteria are used in all CAMP workshops to assess and assign a category to each species.

For the CAMP Workshop CBSG has developed a Taxon Data Sheet and a Spreadsheet format which includes parameters necessary to assess the IUCN status as well as provide other useful information necessary for creating management and action plans. The spreadsheet organises the information in a concise manner so that it is accessible at a glance. The information in this Report is organised on spreadsheets in the Report section, followed by the individual Taxon Data Sheets. A CAMP Workshop also utilises principles of management psychology to guide human interaction. A set of Guidelines for Group Interaction is presented to the workshop participants who agree as a group to work accordingly in order to complete the task. Objective Facilitators (persons trained in management skills and the workshop process) are used to lead and guide the workshop so that individual and professional bias does not affect group decisions and to assist in maintaining the integrity and focus of the workshop.

CAMP Workshops bring together a variety of specialists and enthusiasts from academic, government, managerial, and even the commercial sector to evaluate taxa for setting priorities for conservation action. The fear of loss and hope of recovery of species drives CAMP Workshops. Individuals part with unpublished information in order to contribute to a body of information which will provide strategic guidance for application of intensive management and information gathering. CAMP Workshops results, are, or should be, dynamic, leading to specific conservation activities in forest, market, classroom, courtroom — locally and nationally as well as on the international stage.

Conservation of Indian Mangroves

The Coastal landscape consists of an array of bounded in-shore ecosystems with certain physiologically specialised and ecologically adapted plants, which have evolved remarkable adaptations to survive in sand, mud and tidal situations. These ecosystems have become vulnerable to exploitation by local people leading to changes involving a rapid eco-degradation of the whole.

Mangroves are estuarine, especially along the tidal riverbanks, shallow lagoons, backwater creeks, mud flats and depressed basins under tidal ebb and flow. It is obvious that plants growing under tidal influence possess varied structural modifications to overcome the saline and water logged conditions. The existence of correlation is striking between the saline situation and the adaptive features of the mangrove as evidenced by the appearance or disapperarance of vivipary, pneumatophores or breathing roots of bizarre forms, buttressed trunks and succulence in leaves in a graded sequence along tidal to upslope of the habitat. They constitute a "guild" due to their special mode of life rather than a forest type as thought of by some.

The classification of the sea-shores in different parts of the world has received much attention from ecologists for several years. Most of the classifications deal with the intertidal region and its flora and fauna. Recognition of biological zones, the pattern of their arrangements and the inventory of the flora and fauna have helped to build a solid system of classification of universal applicability despite minor variations in the number of zones from region to region or from author to author.

In India, Champion (1936) proposed a preliminary classification based on physiognomic dominance of plant communities into vegetation types. Of the several types recognised he had grouped the coastal vegetation under Moist tropical seral types into Beach forests and Tidal forests purely based on edaphic conditions under which they grow. The coastal terrestrial communities were reclassified by Champion and Seth (1968) under Moist tropical forests into Littoral and Swamp forest taking into account the situations under which they were growing. The classification proposed by Champion and Seth (1968) has a regional overtone in respect of Sunderbans of West Bengal and ill-suited to other coastal regions of peninsular India, especially to non-deltaic West coast of India. Similarly, a few classifications based on tidal inundation have limited applicability and need more studies from that angle.

During the recent year, based on extensive field data, Rao and Sastry (1974 b) have proposed a reclassification of the Indian coastal vegetation in greater detail, but adhering to the original framework given by Champion and Seth (1968). Blasco (1975) has treated the entire coastal vegetation under the collective term 'Mangrove' and the details are worked out in respect of zonation, ecology, flora, silviculture and dynamism in respect of different coastal regions in India. In the past, Indian field biologists have classified the mangrove vegetation on a regional basis giving particular attention to the flora distribution without critical evaluation of the mangroves niches. Some of the classifications are purely subjective, and not done as an ecosystem in a coordinated basis in respect of tides, geomorphology and soil gradients and salinity percentage.

In India mangrovephytes classification is based on visual and improper studies of a few selected habitats. Further, confusion and anthropogenic influences on mangrove habitats are not taken into record, but accorded the same status as distinct natural vegetation. This has led to improper classification as mangroves and associates without differentiating the adaptive characteristics of true mangroves from its nearby associates and also from inland plants occuring near the mangroves habitat without any of the adaptive features of eumangroves. To overcome this difficulty, it is imperative to consider mangroves under intertidal habitats as a whole with a clear cut subdivision under 3 categories namely estuarine, eumangroves and proestuarine (euobligate), which includes prohaline and euhaline and eufacultative (transgress) taxa. Each of these categories are described in Table 1 followed by representative taxon under each category in Table 2. This classification depicts their fidelity placement and adaptive features so as to help conservation, afforestation and regeneration problems.

Goals of the workshop on Indian mangroves

1. To assess the conservation status and assign an IUCN Red List ranking to taxa of Indian mangroves using population, habitat and threat information. Selected mangrove associates such as algae, invertebrates and fishes of India named by workshop participants at the BCPP CAMP were also assessed.
2. To provide information about the species, which would be useful in drawing up species specific as well as ecosystem specific action plans and management plans, including recommendations for *in situ* and *ex situ* management, research, survey and monitoring, cultivation, investigation of limiting factors, taxonomic and other specific research, education and activism.
3. To produce a Conservation Assessment and Management Plan Report for the species of mangroves and selected associates of flora and fauna, which after review and comment by workshop participants, would be distributed to all individuals and agencies relevant to mangrove conservation.
4. To provide a forum for interactive discussion on mangroves as an ecosystem and design ecosystem based management plans.

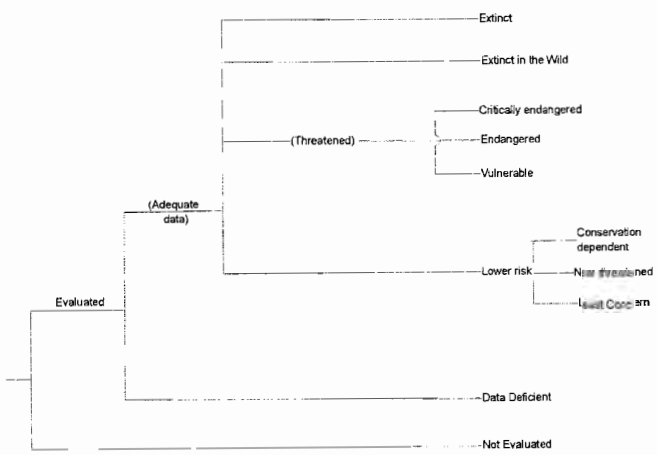
Results and Discussion

Not a single species of mangroves or its associated fauna such as invertebrates and fishes or flora such as algae is listed in any Red Data Book. It is generally known that the mangrove ecosystem is threatened in India and that there is more than 50% reduction in mangroves in the last 50 years. However, there had been no systematic assessment of the status of individual mangrove species. At the CAMP workshop described in this Report, individual species were assessed according to the IUCN categories of 1994.

As mentioned previously, the IUCN categories have undergone a series of revisions since 1991 to enhance their applicability to organisms other than mammals and to reflect the last two decades' development of new conservation sciences, population dynamics and conservation biology. The version of the IUCN categories used in this workshop is the most recent version, which was ratified by the IUCN General Assembly in 1994 and has far more objective criteria for assessment. The categories can be divided into 5 divisions, viz.

1. Extinct (Extinct and Extinct in the wild),
2. Threatened (Critically Endangered, Endangered and Vulnerable)
3. Non-threatened (Lower Risk – near threatened, conservation dependent and least concern)
4. Data Deficient and
5. Not Evaluated.

Structure of the Categories



Methodology

Global Red Lists and Red Data Books, for the most part, have been a compilation of information by one person or a group of persons, usually from temperate countries, who have access to all available literature on distribution and ecological information with reference to a particular species. The status according to old IUCN categories was derived based on these individual's perception of the status as understood from literature. Later, this exercise was broadened to include some range country representatives from different continental regions if indeed the exercise was global in scope, such as the IUCN Red Data Books. In India national assessment such as the Indian Red Data Books relied on some specialists from the different regions of the country. Thus, there are many different methods in deriving status categories by different groups both internationally (such as those done by BirdLife International, World Conservation Monitoring Centre and the different Specialist Groups of the IUCN) and nationally (such as – for India – Botanical Survey of India or Zoological Survey of India). In all of these methods, specialists were asked to provide information on a taxon, which was gathered by post and evaluated by the coordinator at a central office. However they were coordinated, all the above methods of deriving status for a Red Data Book or other species review follow the IUCN Red List categories.

The methodology for assessment of threat adopted in India at a Conservation Assessment and Management Plan Workshop depends upon on-the-spot interaction between specialists and is, therefore, quite different from other methods which rely on data assembled by indirect methods. The objective is the same but in a CAMP Workshop every attempt is made to assemble a representative group of field biologists with direct field experience of the species and their habitat. Information is collected from several sources on the target taxa. Small working groups discuss this information as compared to the personal field experience of participants interactively and extensively until the group reaches a consensus on every fact.

The questionnaire form described earlier (the Taxon Data Sheet, based on IUCN guidelines for deriving status as well as some additional questions) is provided and used to record this consensually processed information. Prior to the workshop, Biological Information Sheets (user-friendly Taxon Data Sheet) were sent to all mangrove specialists and people on the invitation list for information on species they had surveyed. These sheets were later used at the workshop, which ensured participation and input from those who could not attend the workshop but had returned the information sheets with information. The advantages of being able to have discussions on information provided by several active field biologists as opposed to one person compiling data is, or should be, self-evident. Among the advantages of accruing better quality and quantity of information, the payoff resulting from participant "buy in" of the process is most worthwhile. In a national assessment this can have very positive effects on future research.

The Conservation Assessment and Management Plan for Indian mangroves was aimed to cover all mangrove plant taxa of India which number about 60 along with its associates such as marine algae, marine fishes and marine invertebrates. At the beginning of the workshop a strategy was decided for the exercise and participants divided into four working groups that would assess mangroves according to the above groups. The mangrove plants group split into two groups one for the west coast and the other for the east coast and Andaman and Nicobar Islands. It was also decided to first assess all Indian political endemics before going on to assess non-endemics.

Since this was the first All India exercise in mangrove species status evaluation, it also provided researchers an opportunity to discuss checklists and taxonomy with other mangrove specialists, field biologists and taxonomists in India. Working Groups were formed to discuss special issues as related to mangrove asociated inverterates, fishes and marine algae. A group also discussed the interaction of these associates with mangroves and a Mangrove ecosystem schematic diagram was constructed. A special working group was also convened to discuss the IUCN Criteria as applied to Mangroves.

Assessment

There is no complete list of mangrove species in India. This is because of differences in classification of mangroves by researchers – eumangroves, associates, etc. However, an agreed or "working" checklist of mangrove species for the purpose of the workshop was accepted by participants. According to this list, 59 species of mangrove plants and one seagrass were assessed. With respect to invertebrates, fishes and algae, no checklist was available and the number of species is thought to be quite extensive. However, the participants at the workshop selected some taxa in each of those groups for assessment as per their knowledge and expertise. Therefore the lists of mangrove associate fauna and flora are not complete, rather a few examples of all the groups have been assessed. In all 176 taxa were assessed comprising of 23 algae, 52 fishes, and 41 invertebrates apart from the 60 mangrove plants.

The IUCN categories are stated to work best at the global level. Guidelines for regional or national assessments are being discussed but have not been developed to date. In the absence of national or regional guidelines, however, the current Red List Criteria were used even for national assessments. Certain of the criteria are not so straightforward when applied to a national or regional population, however, it was found that any anomaly was "conservative" in favour of the species. In other words, some of the non-endemic taxa may have been given a higher category than their population status actually deserves. The alternative, however, was to leave off assessing non-endemic taxa until specific national/ regional guidelines are developed, a process which could take years. In India, "wildlife" definition and legislation applies to all wildlife occurring naturally in India with no prejudice towards endemic species. While endemicity enhances the conservation value of a species, other considerations – legislative, ecosystemic, etc - are also valid. A biodiversity inventory should include all species.

Of the 176 taxa assessed only a few are Indian endemics. Most of the mangrove plants have a distribution beyond the political boundaries of India thereby making them non-endemics. Similarly many marine fishes and algae have a distribution beyond the country's political limits and therefore are non-endemics.

Results

Mangrove plants

A total of 60 taxa of mangrove plants were assessed at the workshop. A definite number could not be listed because some taxa considered were regarded as "doubtful" due to possibly erroneous identification. Taxonomic confusion and differences in classification of mangrove species added to the difficulty in compiling a complete checklist. However, as stated before, a tentative checklist of Indian mangroves includes some 60 to 70 taxa. The assessments were restricted to only previously described taxa and not those being described at the time of the workshop or in press.

Of the assessed taxa, a total of 23 families are represented among Indian mangrove plants of which family Rhizophoraceae is the most represented followed by Poaceae and Chenopodiaceae. All other families have 4 or less taxa representing them.

Table 1. Taxa and families of mangrove plants assessed

SPECIES	IUCN
Acanthaceae	
Acanthus ebracteatus	CR
Acanthus ilicifolius	EN
Acanthus volubilis	CR
Aizoaceae	
Sesuvium portulacastrum	EN
Apocynaceae	
Cerbera manghas	EN
Arecaceae	
Nypa fruticans	EN
Phoenix paludosa	EN
Asclepiadaceae	
Finlaysonia obovata	CR
Avicenniaceae	
Avicennia alba	CR
Avicennia marina var. acutissima	EN
Avicennia marina var. resinifera	CR
Avicennia officinalis	EN
Chenopodiaceae	
Arthrocnemum indicum	VU
Salicornia brachiata	LRnt
Suaeda maritima	EN
Suaeda monoica	EN
Suaeda nudiflora	EN
Combretaceae	
Lumnitzera littorea	CR
Lumnitzera racemosa	EN
Euphorbiaceae	
Excoecaria agallocha	VU
Fabaceae	
Cynometra ramiflora	EN
Derris heterophylla	EN
Derris trifoliata	EN
Hydrocharitaceae	
Halophila beccarii	EN
Meliaceae	
Aglaia cuculata	EN
Xylocarpus granatum	EN
Xylocarpus mekongensis	EN
Xylocarpus moluccensis	EN
Mysinaceae	
Aegiceras corniculatum	EN

SPECIES	IUCN
Plumbaginaceae	
Aegialitis rotundifolia	EN
Poaceae	
Aeluropus lagopoides	EN
Myriostachya wightiana	EN
Porteresia coarctata	VU
Sporobolus virginicus	EN
Urochondra setulosa	EN
Poaceae; Panicoidae; Paniceae	
Cenchrus ciliaris	EN
Pteridaceae	
Acrostichum aureum	LRlc
Rhizophoraceae	
Bruguiera cylindrica	EN
Bruguiera gymnorrhiza	CR
Bruguiera parviflora	CR
Bruguiera sexangula	VU
Ceriops decandra	EN
Ceriops tagal	EN
Kandelia candel	EN
Rhizophora annamalayana	NE
Rhizophora apiculata	EN
Rhizophora lamarckii	CR
Rhizophora mucronata	VU
Rhizhophora stylosa	CR
Rubiaceae	
Scyphiphora hydrophyllacea	EN
Sonneratiaceae	
Sonneratia alba	EN
Sonneratia apetala	EN
Sonneratia caseolaris	EN
Sonneratia griffithii	CR
Sterculiaceae	
Heretiera fomes	EN
Heretiera kanikensis	CR
Heretiera littoralis	EN
Tamaricaceae	
Tamarix troupii	EN
Tiliaceae	
Brownlowia tersa	EN
Verbenaceae	
Clerodendrum inerme	EN

Table 2. Criteria used in assessing threatened mangrove plant taxa

Species	IUCN	Assessed for	Threatened due to	Criteria
Acanthus ebracteatus	CR	A & N Is.	Restricted distribution	B1, 2c
Acanthus ilicifolius	EN	E. & W. coast, A & N Is.	Restricted distribution	B1, 2c
Acanthus volubilis	CR	E. coast, A & N Is.	Restricted distribution	B1, 2c
Acrostichum aureum	LR-lc	E. & W. coast, A & N Is.	—	—
Aegialitis rotundifolia	EN	E. coast, A & N Is.	Restricted distribution	B1, 2c
Aegiceras corniculatum	EN	E. & W. coast	Restricted distribution	B1, 2c
Aeluropus lagopoides	EN	E. & W. coast, salt pans	Restricted distribution	B1, 2b
Aglaia cuculata	EN	E. coast, A & N Is.	Restricted distribution	B1, 2c
Arthrocnemum indicum	VU	E. & W. coast	Population reduction	A1a, 1b
Avicennia alba	CR	E. & W. coast, A & N Is.	Population reduction	A1a, 1c
Avicennia marina var. acutissima	EN	E. & W. coast	Population reduction	A1c, 1d
Avicennia marina var. resinifera	CR	W. coast	Restricted distribution, Population estimation, Restricted population	B1, 2b, 2c, 2d; C2d; D2

Species	IUCN	Assessed for	Threatened due to	Criteria
Avicennia officinalis	EN	E. & W. coast	Restricted distribution	B1, 2b
Brownlowia tersa	EN	E. coast, A & N Is.	Restricted distribution	B1, 2c
Bruguiera cylindrica	EN	E. & W. coast, A & N Is.	Population reduction, Restricted distribution	A1c, 1d, 2d; B1, 2c
Bruguiera gymnorrhiza	CR	E. & W. coast, A & N Is.	Population reduction	A1c, 1d
Bruguiera parviflora	CR	E. & W. coast, A & N Is.	Population reduction	A1c, 1d
Bruguiera sexangula	VU	E. coast, A & N Is.	Restricted distribution	B1, 2c, 2d
Cenchrus ciliaris	EN	E. & W. coast, dry inland areas	Restricted distribution	B1, 2c
Cerbera manghas	EN	E. & W. coast	Restricted distribution	B1, 2c
Ceriops decandra	EN	E. & W. coast, A & N Is.	Population reduction, Restricted distribution	A1c, 1d, 2d; B1, 2c
Ceriops tagal	EN	E. & W. coast, A & N Is.	Restricted distribution	B1, 2a, 2c
Clerodendrum inerme	EN	E. & W. coast	Restricted distribution	B1, 2c
Cynometra ramiflora	EN	E. coast, A & N Is.	Restricted distribution	B1, 2c
Derris heterophylla	EN	E. & W. coast, A & N Is.	Restricted distribution	B1, 2c
Derris trifoliata	EN	E. & W. coast	Restricted distribution	B1, 2c
Excoecaria agallocha	VU	E. & W. coast	Restricted distribution	B1, 2c
Finlaysonia obovata	CR	E. coast, A & N Is.	Restricted distribution	B1, 2c
Halophila beccarii	EN	E. & W. coast	Restricted distribution	B1, 2c, 2d
Heretiera fomes	EN	E. coast, A & N Is.	Restricted distribution	B1, 2b, 2c
Heretiera kanikensis *	CR	E. coast	Restricted distribution, Population estimation, Restricted population	B1, 2c; C2b; D2
Heretiera littoralis	EN	E. & W. coast, A & N Is.	Population reduction, Restricted distribution	A2b, 2c, 2d; B1, 2c
Kandelia candel	EN	E. & W. coast	Restricted distribution	B1, 2c
Lumnitzera littorea	CR	E. coast, A & N Is.	Restricted distribution	B1, 2c
Lumnitzera racemosa	EN	E. & W. coast	Restricted distribution	B1, 2c
Myriostachya wightiana	EN	E. coast	Restricted distribution	B1, 2c
Nypa fruticans	EN	E. coast, A & N Is.	Restricted distribution	B1, 2a, 2b, 2c
Phoenix paludosa	EN	E. coast, A & N Is.	Restricted distribution	B1, 2c
Porteresia coarctata	VU	E. & W. coast	Restricted distribution	B1, 2c
*Rhizophora anamalayana**	NE	E. coast	—	—
Rhizophora apiculata	EN	E. & W. coast	Population reduction	A2b, 2d;
Rhizophora lamarckii	CR	E. coast, A & N Is.	Restricted distribution, Population estimation	B1, 2c; C2a
Rhizophora mucronata	VU	E. & W. coast	Population reduction, Restricted distribution	A2c, 2d; B1,2c
Rhizhophora stylosa	CR	E. coast, A & N Is.	Restricted distribution	B1, 2c
Salicornia brachiata	LRnt	E. & W. coast	—	—
Scyphiphora hydrophylaceae	EN	E. coast, A & N Is.	Restricted distribution	B1, 2c
Sesuvium portulacastrum	EN	E. & W. coast	Restricted distribution	B1, 2c
Sonneratia alba	EN	E. & W. coast	Population reduction	A2c, 2d
Sonneratia apetala	EN	E. & W. coast	Population reduction, Restricted distribution	A2b, 2c, 2d; B1, 2c
Sonneratia caseolaris	EN	E. & W. coast, A & N Is.	Population reduction, Restricted distribution	A2b, 2c, 2d; B1, 2c
Sonneratia griffithii	CR	E. coast, A & N Is.	Restricted distribution	B1, 2c
Sporobolus virginicus	EN	W. coast	Restricted distribution	B1, 2c
Suaeda maritima	EN	E. & W. coast	Restricted distribution	B1, 2b, 2c
Suaeda monoica	EN	E. & W. coast	Restricted distribution	B1, 2a, 2b, 2c
Suaeda nudiflora	EN	E. & W. coast	Restricted distribution	B1, 2a, 2c
Tamarix troupii	EN	W. coast	Restricted distribution	B1, 2b, 2c, 2d
Urochondra setulosa *	EN	W. coast	Restricted distribution	B1, 2c
Xylocarpus granatum	EN	E. & W. coast	Population reduction, Restricted distribution	A1acd, 2bcd; B2a, 2b, 2c
Xylocarpus mekaongensis	EN	E. coast, A & N Is.	Restricted distribution	B1, 2c
Xylocarpus moluccensis	EN	E. coast, A & N Is.	Restricted distribution	B1, 2c

* Indian endemics, assessed Globally.

Threats

Most of the taxa assessed at this workshop are under threat (Table 3). Habitat loss, human interference and trade are the main threats affecting mangrove plant taxa in India.

Threats can be classified into those affecting the habitat and those affecting the taxon population, though some of the factors affect both habitat and population. With reference to habitat quality changes, any small or large impact of human interference on the habitat could affect the regeneration capability or the habitat structure of the area, or the individual taxon in question. Therefore threats affecting habitat and threats affecting populations are not independent of each other.

Threats affecting habitat such as logging, cultivation, human settlements, fragmentation, introduction of exotic plants or monocultures and plantations are the main contributing factors to the taxa assessed here. All these along with factors that affect population numbers such as human interference, overexploitation, harvesting for various purposes and trade result in many of the taxa having been evaluated as threatened.

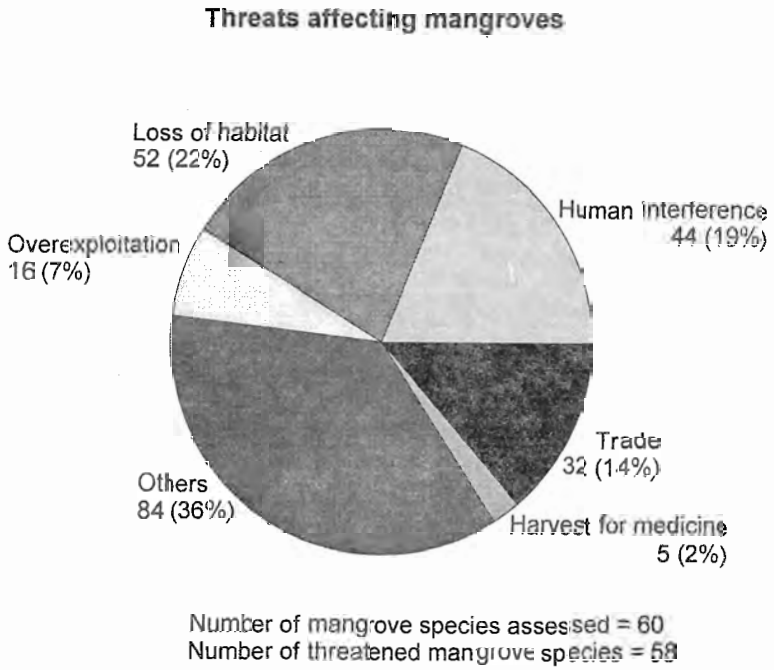


Table 3. Threat and trade information for selected species of Indian mangrove plants assessed according to the New IUCN categories

SPECIES	THREATS	IUCN
Acanthus ebracteatus	Loss of habitat	CR
Acanthus ilicifolius	Damming, Human interference, Harvest, Loss of habitat	EN
Acanthus volubilis	Harvest for medicine, Loss of habitat	CR
Acrostichum aureum	No	LR-lc
Aegialitis rotundifolia	Human interference, Loss of habitat	EN
Aegiceras corniculatum	Cattle grazing, Human interference, Loss of habitat, Trade (L)	EN
Aeluropus lagopoides	Cattle grazing, Human interference, Loss of habitat, Trade (L)	EN
Aglaia cucullata	Loss of habitat, Trade (L, D)	EN
Arthrocnemum indicum	Loss of habitat	VU
Avicennia alba	Genetic problems, Human interference, Loss of habitat, Pollution	CR
Avicennia marina var. acutissima	Cattle grazing, Human interference, Harvest, Harvest for food, Loss of habitat, Over exploitation, Trade (L, D)	EN
Avicennia marina var. resinifera	Human interference, Loss of habitat	CR
Avicennia officinalis	Cattle grazing, Damming, Human interference, Harvest for food, Harvest for timber, Harvest, Loss of habitat, Over exploitation, Trade (L)	EN
Brownlowia tersa	Loss of habitat	EN
Bruguiera cylindria	Human interference, Harvest for timber, Harvest, Loss of habitat, Over exploitation, Trade (D,C)	EN
Bruguiera gymnorrhiza	Human interference, Harvest for timber, Harvest, Harvest for medicine, Loss of habitat, Over exploitation, Trade (D,C)	CR
Bruguiera parviflora	Human interference, Harvest for timber, Harvest, Loss of habitat, Over exploitation, Trade (L)	CR
Bruguiera sexangula	Human interference, Loss of habitat	VU
Cenchrus ciliaris	Cattle grazing, Human interference, Pollution, Trade (L, D)	EN
Cerbera manghas	Human interference, Harvest, Trade (L), Trade for pets	EN
Ceriops decandra	Human interference, Harvest for timber, Harvest, Loss of habitat, Over exploitation, Trade (D	EN

SPECIES	THREATS	IUCN
Ceriops tagal	Human interference, Harvest for timber, Harvest, Hm, Loss of habitat, Over exploitation, Trade (D)	EN
Clerodendrum inerme	Climate, Human interference	EN
Cynometra ramiflora	Human interference, Harvest for timber, Loss of habitat, Over exploitation, Trade (D)	EN
Derris heterophylla	Human interference, Harvest for medicine, Loss of habitat, Trade (L)	EN
Derris trifoliata	Human interference, Harvest for medicine, Loss of habitat, Trade (L)	EN
Excoecaria agallocha	Human interference, Harvest, Loss of habitat, Over exploitation, Trade (L)	VU
Finlaysonia obovata	Human interference, Loss of habitat	CR
Halophila beccarii	Changes in Edaphic factors, Human interference, Loss of habitat, Siltation	EN
Heretiera fomes	Human interference, Harvest for timber, Loss of habitat	EN
Heretiera kanikensis	Human interference, Harvest for food, Loss of habitat	CR
Heretiera littoralis	Climate, Human interference, Harvest for timber, Harvest, Loss of habitat, Over exploitation, Trade (L)	EN
Kandelia candel	Human interference, Harvest, Loss of habitat, Pollution	EN
Lumnitzera littorea	Human interference, Loss of habitat	CR
Lumnitzera racemosa	Human interference, Harvest, Loss of habitat	EN
Myriostachya wightiana	Harvest, Trade for parts, Trade (L)	EN
Nypa fruticans	Human interference, Harvest, Harvest for food	EN
Phoenix paludosa	Loss of habitat, Over exploitation, Trade (L), Trade for parts	EN
Porteresia coarctata	Cattle grazing, Human interference, Loss of habitat, Siltation	VU
Rhizophora annamalayana	Genetic problems, Human interference, Harvest for food, Loss of habitat	NE
Rhizophora apiculata	Climate, Harvest for timber, Harvest, Loss of habitat, Over exploitation, Pollution, Trade (C, D)	EN
Rhizophora lamarckii	Genetic problems, Hybridization, Loss of habitat	CR
Rhizophora mucronata	D, Human interference, Harvest for timber, Harvest, Loss of habitat, Over exploitation, Trade for parts, Trade (C, D)	EN
Rhizhophora stylosa	Human interference, Loss of habitat	CR
Salicornia brachiata	Climate, Changes in Edaphic factors, Fishing, Harvest for food, Loss of habitat, Pollution, Trade (L, D)	LR-nt
Scyphiphora hydrophylaceae	Human interference, Loss of habitat	EN
Sesuvium portulacastrum	Human interference, Harvest for food, Loss of habitat	EN
Sonneratia alba	Cattle grazing, Climate, Damming, Human interference, Harvest for timber, Harvest, Loss of habitat, Over exploitation, Trade (L, D)	EN
Sonneratia apetala	Climate, Human interference, Harvest for timber, Harvest, Loss of habitat, Over exploitation, Pollution, Trade (L)	EN
Sonneratia caseolaris	Climate, Human interference, Loss of habitat, Over exploitation, Trade(L)	EN
Sonneratia griffithii	Loss of habitat	CR
Sporobolus virginicus	Human interference, Loss of habitat, Cattle grazing, Trade (L)	EN
Suaeda maritima	Human interference, Loss of habitat	EN
Suaeda monoica	Climate, Human interference, Loss of habitat	EN
Suaeda nudiflora	Climate, Human interference, Loss of habitat	EN
Tamarix troupii	Human interference, Loss of habitat	EN
Urochondra setulosa	Landslide, Siltation	EN
Xylocarpus granatum	Climate, Human interference, Harvest for timber, Harvest, Loss of habitat, Over exploitation, Trade	EN
Xylocarpus mekaongensis	Harvest for timber, Loss of habitat	EN
Xylocarpus molluccensis	Changes in Edaphic factors, Genetic problems, Harvest for timber, Harvest, Loss of habitat	EN

Trade

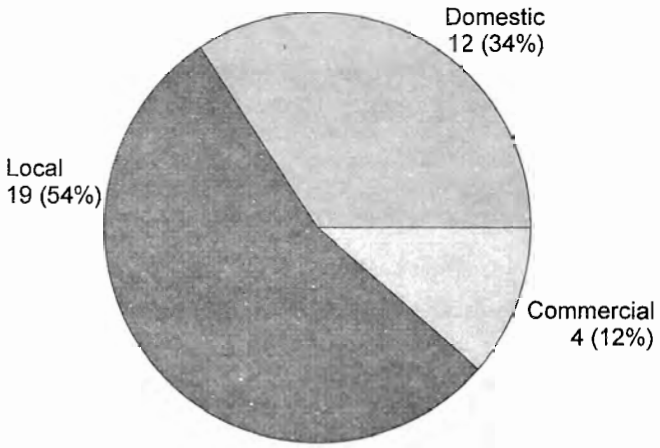
Of the very many different kinds of threats, trade plays a considerable part in causing mangrove taxa to be categorised as threatened. Trade and other factors that work along with those such as narvest, harvest for medicine, harvest for timber and harvest for food comprise a major liability to the mangrove plants.

In the present exercise it is seen that 45% of all the assessed taxa and 43% of threatened taxa are in trade (Table 3).

Subsistence living can also take a toll on the survival of some taxa. Recent trends in reduction of wild populations by a variety of threats have resulted in decline in the populations of the taxa. Hence, any unsustainable utilisation, even for subsistence living could tip the scale.

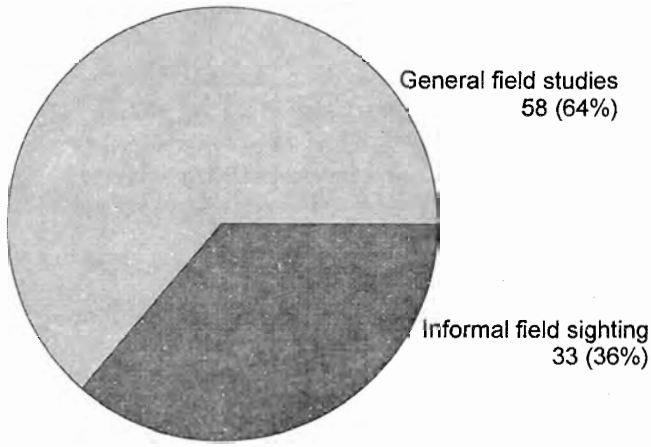
Twenty-seven taxa are assessed to be in trade (Table 3). Depending on the scope and quantity of trade, four levels such as local trade, domestic trade, commercial trade and international trade are listed. While some of the taxa are being traded at one level only, many are being traded at two or more levels. Most of the trade is either at local,

Trade in threatened mangrove taxa



Number of threatened taxa in trade = 26

Data quality



commercial or domestic levels while a few taxa are traded internationally (Figure and Table 3).

Twenty-six of the threatened taxa are categorised to be in trade (Table 3). Trade along with other factors is a threat to the survivability of the taxon in the wild. Figure below indicates different levels of trade of threatened taxa.

Trade has been a contentious issue for the last many years and has assumed greater importance in recent years due to factors, which compromise the biodiversity convention, indigenous people's rights, and foreign trade. The most recent "scare" is patents, which have aroused much suspicion and frustration among the Indian political, economic, and scientific community towards countries whose actions compromise local community rights in India. However, there are no mangrove taxa that are in international trade.

Data Quality

Data quality for all taxa assessed in this workshop is either by or a combination of General field studies (58 taxa), Informal field sighting (33 taxa). Reliable census information is not available for a single taxon, based on which the assessment could be made. However, general field studies and informal sightings for most of the taxa had enough information in categorising taxa under the IUCN categories since most of the information was based on restricted distribution.

The IUCN guidelines for assessment clearly suggest a "conservative" approach in favour of the taxa, e.g. " . . . the absence of high quality data should not deter attempts at applying the criteria, as methods involving estimation, inference and projection are emphasized to be acceptable throughout. Inference and projection may be based on extrapolation of current or potential threats into the future (including dependence on other taxa), so factors related to population abundance or distribution (including dependence on other taxa), so long as these can reasonably be supported. Suspected or inferred patterns in either the recent past, present or near future can be based on any of a series of related factors, and these factors should be specified. Taxa at risk from threats posed by future events of low probability but with severe consequences (catastrophes) should be identified by the criteria (e.g. small distribution, few locations). Some threats need to be identified particularly early, and appropriate actions taken, because their effects may be irreversible, or nearly so (pathogens, invasive organisms, hybridization)."

The exercise to determine the status of any taxon should not be hindered by the fact that there is no hard information available. Thorough, all-encompassing hard data is practically impossible to gather for even a single taxon, and the time required to actually gather such detailed information could delay conservation measures for threatened taxa. The combination of elements which make up a CAMP workshop such as group effort of botanists including field workers, both past and present, museum curators, ecologists, theoreticians, policy makers and related specialists together, good faith and impartial facilitation provide informed advice for conservation action planning. The results of this Workshop are an outcome of such an exercise.

Conservation action and recommendations

The previous section dealt with the different values for assessing the IUCN categories for the taxa. This section deals with the need for conservation action to be taken to insure that the taxa are conserved in the wild and that their habitat is safe. Conservation action can take many forms. The first action is keeping the habitat inviolate, which may be the best way of insuring survival of taxa. However, habitat protection alone may not be sufficient. Constant pressure on habitat and individual taxa has forced many taxa to become threatened. This creates other complications such as small and isolated or fragmented populations, which may propel the taxon into an "extinction vortex". To overcome these complications and possible extinction, remedial actions need to be taken up simultaneously.

An understanding of the basic biology and behaviour of a taxon can also help in identifying individual areas of conservation action and implementation.

Table 4 shows that Monitoring has been recommended for 52 of the 60 taxa followed by Habitat management, Survey, Limiting factor research, Taxonomic studies, Life history studies, Limiting factor management, Genetic management, Husbandry research and other taxon specific recommendations.

Monitoring studies have been carried out for many taxa for population and habitat to determine population trends or effects of harvest and other human-influenced changes in the environment. Monitoring has been strongly recommended for future action plans. For many taxa whose extent of occurrence far exceeds the area of occupancy, the recommendation is for more surveys within the range as to identify other locations. Most of the assessed taxa are not very well understood in terms of their basic biology or husbandry for cultivation. Since they are traded and being exploited in the wild for medicinal and other

purposes, cultivation for sustainable utilisation has been recommended as one of the most urgent tasks. However, in many cases propagation techniques are yet to be perfected or no attempt at all has been made to cultivate the taxa. For this reason, husbandry research, limiting factor research and life history studies have been recommended for many taxa.

Recommendations for the assessed taxa include those described above and also Population and Habitat Viability Assessment and Cultivation. Forty-eight threatened taxa are recommended for cultivation. Population and Habitat Viability Assessment is recommended for 4 of the 26 threatened taxa.

Cultivation and the level of difficulty

Cultivation recommendations are at four levels, Levels 1, 2, 3 and 4 (see taxon data sheet definitions). Level 1 is for taxa to be interactively managed *in situ* and *ex situ* so as to retain 90% genetic diversity for 100 years. Level 2 is for *ex situ* populations to be infused with fresh genetic material from the wild so as to retain sufficient diversity. Level 3 is not for conservation but only for education, husbandry and research. Level 4 is for commercial and sustainable utilisation.
In this workshop, a cultivation programme for 48 of the threatened taxa is recommended (Table 5), although for most of the taxa techniques for cultivation are not in place or still very difficult. Level of difficulty of cultivating the taxa is given in table 6.

Research and management recommendations

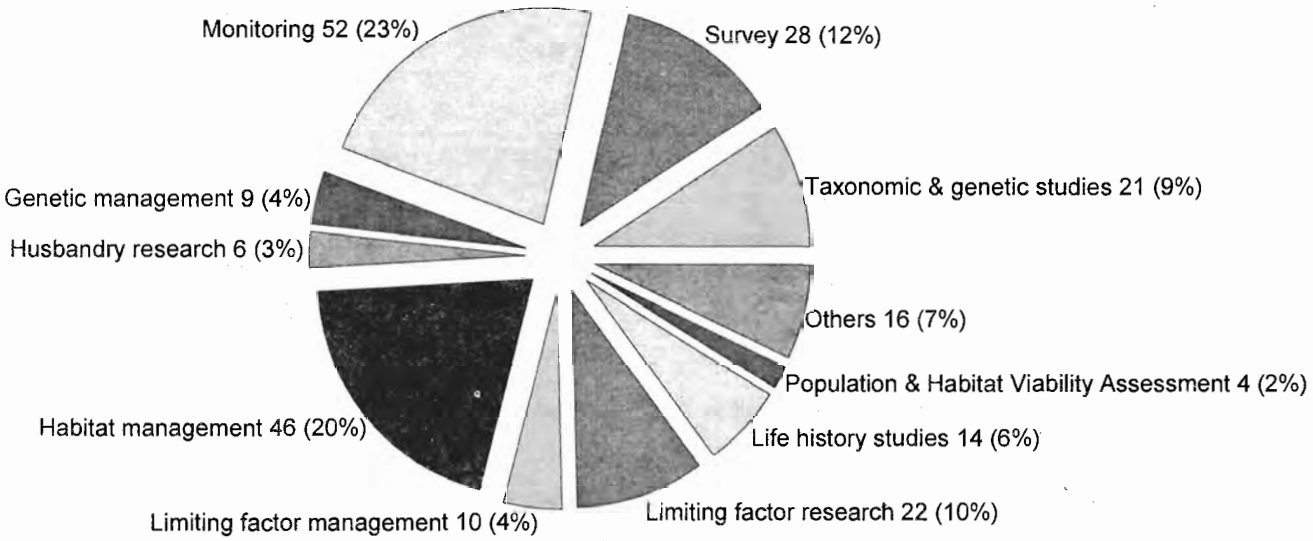


Table 4. Research and management recommendations for mangrove taxa

	T	S	M	G	H	Hm	Lm	Lr	Lh	P	O
CR	5	9	12	3	-	10	-	7	3	3	2
EN	13	16	33	5	5	31	9	13	9	1	12
VU	2	2	5	1	1	4	1	1	1	-	-
LR-nt	-	-	-	-	-	-	-	-	-	-	1
LR-lc	-	-	1	-	-	-	-	-	-	-	1
DD	-	-	-	-	-	-	-	-	-	-	-
NE	1	1	1	-	-	1	-	1	1	-	-
Total	21	28	52	9	6	46	10	22	14	4	16

Table 5. Cultivation recommendations for mangrove plants

Cultivation	Level 1	Level 2	Level 3	Level 4	Pend.	No
CR	10	1	-	-	2	-
EN	17	13	4	-	5	2
VU	1	2	2	-	-	1
LRnt	-	-	-	-	-	1
LRlc	-	-	-	-	-	1
DD	-	-	-	-	-	-
NE	-	-	-	-	1	-
Total	28	16	6	0	8	5

Table 6. Level of difficulty in cultivating mangrove plants

Level of difficulty	Level 1	Level 2	Level 3	Unknown
CR	3	2	6	1
EN	8	15	7	10
VU	2	2	-	1
LRnt	1	-	-	-
LRlc	-	-	-	1
DD	-	-	-	-
NE	-	-	1	-
Total	14	19	14	13

There are very few systematic and patient efforts in developing techniques for mangrove taxa in trade. Of the 60 taxa, cultivation knowledge exists for 33 taxa. Cultivation techniques are in place and propagation is easy for 14 taxa, while techniques are not in place for cultivation or cultivation is very difficult for 14 taxa. The remaining 31.6% of the plants are only partially understood for cultivation (Table 6).

Mangroves are being overexploited from the wild for local and domestic trade. Populations have shrunk to the extent that any harvest even for subsistence living could result in the plant going extinct. It is therefore suggested that cultivation be taken up to meet all of the demands of the local and domestic needs. Cultivation is a must for there is no alternative if the taxon is to survive in the wild. Any delay would only mean that a much-depleted wild gene pool only would be available to utilise for cultivation programmes.

Marine algae

Twenty-three taxa of marine algae were assessed at the mangrove CAMP. This was the first time that any algal species was assessed at the species level using the IUCN categories. The IUCN categories are applicable to all taxa except microorganisms. The taxa of marine algae chosen for assessment were therefore macroorganisms though colonies of thallus were considered as single individuals rather than every strand or cell. The algal taxa were also chosen based on their dependence on mangroves. Though some of the taxa are found along the coasts of India, most of the marine algae are dependent on mangroves. Reduction in the extent of occurrence of mangroves has resulted in the reduction of marine algae. All of the threatened taxa were based on the criteria of restricted distribution. Only one species of algae is endemic to India and was assessed globally, while the rest were assessed nationally since their distribution extended beyond the political limits of the country.

Table 7. Family-wise listing of algae assessed at the worshop

Taxon	IUCN
Catnellaceae	
Caloglossa leprieurii	EN
Catnella impudica	EN
Catnella repens	EN
Cladophoraceae	
Chaetomorpha linum	EN
Codiaceae	
Codium fragile	EN
Dichotomosiphon salina *	CR
Colpomeniaceae	
Colpomenia sinuosa	LRnt
Dictyotaceae	
Dictyota indica	EN
Padina tetrastromatica	LRnt
Spatoglossum asperum	LRnt
Gracilariaceae	
Gracilaria verrucosa	EN
Hypneaceae	
Hypnea musciformis	LRnt

Taxon	IUCN
Monostromataceae	
Monostroma oxyspermum	EN
Polysiphonaceae	
Bostrychia tenella	EN
Rhizocloniaceae	
Rhizoclonium ciperium	EN
Rhizoclonium kerneri	LRnt
Rhizoclonium kochianum	LRnt
Sargassaceae	
Sargassum ilicifolium	LRnt
Ulvaceae	
Enteromorpha clathrata	LRlc
Enteromorpha intestinalis	LRnt
Ulva patengansis	CR
Ulva reticulata	EN
Vaucheraiceae	
Vaucheria prescottii	EN

Table 8. List of mangrove associated marine algae assessed

Taxon	Assessed for	IUCN	Threatened due to	Criteria
Bostrychia tenella	E. & W. coast	EN	Restricted distribution	B1, 2c
Caloglossa leprieurii	E. & W. coast & islands	EN	Restricted distribution	B1, 2c
Catenella impudica	E. & W. coast	EN	Restricted distribution	B1, 2c
Catenella repens	E. & W. coast & islands	EN	Restricted distribution	B1, 2c
Chaetomorpha linum	E. & W. coast	EN	Restricted distribution	B1, 2a, 2b, 2c
Codium fragile	E. & W. coast & islands	EN	Restricted distribution	B1, 2c
Colpomenia sinuosa	E. & W. coast & islands	LR-nt	No	No
Dichotomosiphon salina *	W. coast	CR	Restricted distribution	B1, 2b, 2c, 2d

Taxon	Assessed for	IUCN	Threatened due to	Criteria
Dictyota indica	W. coast, A & N Is.	EN	Restricted distribution	B1, 2a
Enteromorpha clathrata	E. & W. coast	LR-lc	—	—
Enteromorpha intestinalis	E. & W. coast	LR-nt	—	—
Gracilaria verrucosa	E. & W. coast	EN	Restricted distribution	B1, 2b, 2c
Hypnea musciformis	E. & W. coast & islands	LR-nt	—	—
Monostroma oxyspermum	W. coast	EN	Restricted distribution	B1, 2c
Padina tetrastromatica	E. & W. coast & islands	LR-nt	—	—
Rhizoclonium ciperium	E. & W. coast & islands	EN	Restricted distribution	B1, 2c
Rhizoclonium kerneri	E. & W. coast & Islands	LR-nt	—	—
Rhizoclonium kochianum	E. & W. coast	LR-nt	—	—
Sargassum ilicifolium	E. & W. coast & Islands	LR-nt	Unknown	Unk
Spatoglossum asperum	W. coast	LR-nt	—	—
Ulva patengansis	East coast	CR	Restricted distribution	B1, 2c
Ulva reticulata	W. & E. coast	EN	Restricted distribution	B1, 2c
Vaucheria prescottii	E. Coast	EN	Restricted distribution	B1, 2c

Table 9. Threats to marine algae

Taxa	Threats	IUCN
Bostrychia tenella	Human interference, Loss of habitat, Pollution, Siltation	EN
Caloglossa leprieurii	Human interference, Loss of habitat, Pollution, Siltation	EN
Catnella impudica	Loss of habitat	EN
Catnella repens	Human interference, Loss of habitat, Pollution, Siltation	EN
Chaetomorpha linum	Human interference, Loss of habitat	EN
Codium fragile	Human interference, Loss of habitat	EN
Colpomenia sinuosa	Human interference, Loss of habitat	LR-nt
Dichotomosiphon salina *	Human interference	CR
Dictyota indica	Human interference, Loss of habitat	EN
Enteromorpha clathrata	No	LR-lc
Enteromorpha intestinalis	Loss of habitat	LR-nt
Gracilaria verrucosa	Human interference, Loss of habitat, Over exploitation, Trade (C)	EN
Hypnea musciformis	Loss of habitat, Over exploitation, Human Interference, Trade (C, L)	LR-nt
Monostroma oxyspermum	Cattle grazing, Loss of habitat, Human Interference	EN
Padina tetrastromatica	Loss of habitat, Human Interference	LR-nt
Rhizoclonium ciperium	Loss of habitat	EN
Rhizoclonium kerneri	Loss of habitat	LR-nt
Rhizoclonium kochianum	Loss of habitat	LR-nt
Sargassum ilicifolium	Human interference, Loss of habitat, Over exploitation, Trade (L)	LR-nt
Spatoglossum asperum	Loss of habitat	LR-nt
Ulva patengansis	Loss of habitat	CR
Ulva reticulata	Loss of habitat, Predation, Human Interference	EN
Vaucheria prescottii	Loss of habitat	EN

Threats

Marine algae also are threatened: of the 23 taxa assessed, 14 are threatened due to human interference, loss of habitat, pollution and siltation. Marine algae are dependent on mangroves, which are primarily threatened due to factors mentioned earlier.

Because of loss of vegetation upstream, the estuaries get silted with the runoff soil, which in turn settles on the algal thallus and kills them. Human interference in the form of clearing mangroves further threatens the existance of algae. Three of the assessed species are also traded locally and domestically as fodder for livestock and for matress making.

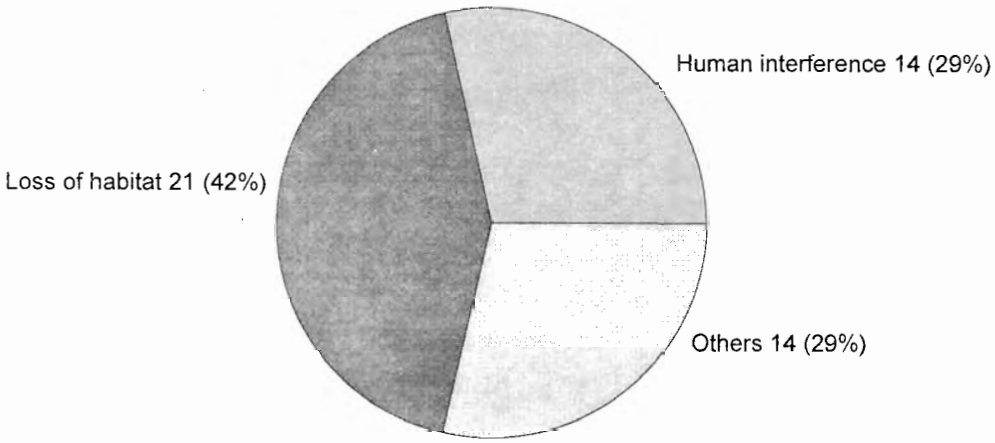
Recommendations

Survey, monitoring, taxonomic, life history and PHVA recommendations have been suggested for marine algae as priority since not much is known about their distribution, biology or population dynamics.

Cultivation recommendation and level of difficulty

Six taxa have been recommended for cultivation for sustainable utilisation while only one has been recommended for cultivation for research. No alga has been recommended for cultivation for conservation. This could be due to the reason that nothing is known about cultivating algae since some information on cultivation is available for only one species while for the rest it is either unknown or too difficult.

Threats affecting marine algae



Number of threatened marine algae = 14
Number of algae assessed = 23

Research and management recommendations

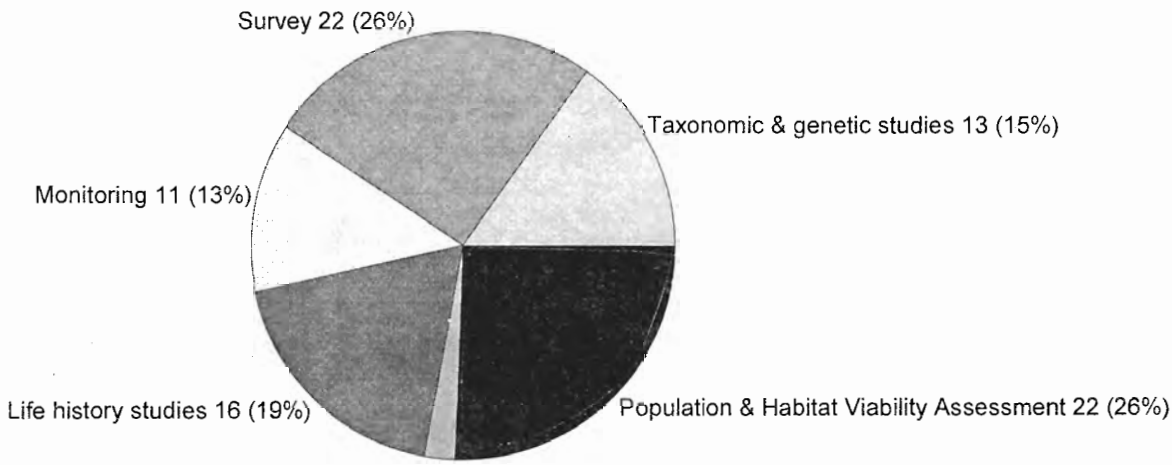


Table 10. Research and management recommendations for algae.

	T	S	M	G	H	Hm	Lm	Lr	Lh	P	O
CR	2	2	1	-	-	-	-	-	1	1	-
EN	7	12	5	-	-	-	-	-	11	12	-
LR-nt	3	7	5	2	-	-	-	-	3	8	-
LR-lc	1	1	-	-	-	-	-	-	1	1	-
DD	-	-	-	-	-	-	-	-	-	-	-
Total	13	22	11	2	0	0	0	0	16	22	0

Table 11. Cultivation recommendations for algae

Cultivation	Level 1	Level 2	Level 3	Level 4	Pend.	No
CR	-	-	-	-	-	2
EN	-	-	-	3	-	9
VU	-	-	-	-	-	-
LRnt	-	-	1	3	-	4
LRlc	-	-	-	-	-	1
DD	-	-	-	-	-	-
NE	-	-	-	-	-	-
Total	0	0	1	6	0	16

Table 12. Level of difficulty in cultivating algae

Level of difficulty	Level 1	Level 2	Level 3	Unknown
CR	-	-	-	2
EN	-	2	1	9
VU	-	-	-	-
LRnt	-	3	1	4
LRlc	-	-	-	1
DD	-	-	-	-
NE	-	-	-	-
Total	0	5	2	16

Mangrove fishes

Fifty-two taxa of marine fishes with direct dependence on mangroves were assessed at the workshop. Marine fishes form an important component of a dynamic mangrove ecosystem since the fingerlings are directly dependent on mangroves for their nourishment and during the growth phase. Mangroves are therefore breeding grounds for many marine fishes. Not much is known about marine fishes, their biology and distribution. However, sufficient information was available at the workshop to assess the population trends based on catch data of marine fishes over the last 3 decades. Eleven of the 52 fishes are threatened with extinction while the rest are near threatened.

Table 13. Family-wise listing of marine fishes assessed at the workshop

Taxon	IUCN
Ambassidae	
Ambassis commersoni	LRnt
Anguillidae	
Anguilla bicolar	LRnt
Ariidae	
Arius subrostratus	VU
Carangidae	
Alecits indicus	LRnt
Carangoides ciliarius	LRnt
Caranx ignobilis	LRnt
Caranx sexfasciates	LRnt
Centropomidae	
Lates calcarifer	LRnt
Psammaperca waigaensis	VU
Chanidae	
Chanos chanos	LRnt
Chichillidae	
Etroplus suratensis	LRnt
Clupidae	
Anodentestoma chacunda	LRnt
Hilsa kelee	LRnt
Nematalosa nasus	LRnt
Tenualosa ilisha	LRnt
Elopidae	
Elopes machnata	VU

Taxon	IUCN
Gobiidae	
Boleophthalmus boddari	VU
Boleophthalmus dussumieri	EN
Glassogobius giurus	LRnt
Periophthalmus koelreuteri	VU
Scartelaos viridis	EN
Leiognathidae	
Leiognathus splendens	VU
Secutor ruconius	VU
Lethrenidae	
Lethrenus nebulosus	LRnt
Lobotidae	
Lobotes surinamensis	LRnt
Lutjanidae	
Lutjanus argentimaculatus	LRnt
Lutjanus fulviflammus	LRnt
Lutjanus johni	LRnt
Lutjanus russelli	LRnt
Lutjanus sebae	LRnt
Megalopidae	
Megalops cyprinoides	LRnt
Mugilidae	
Liza dussumieri	LRnt
Liza macrolepis	LRnt
Liza parsia	LRnt

Taxon	IUCN
Mugil cephalus	LRnt
Osteomugil cunensius	LRnt
Muraenidae	
Muraena macrura	LRnt
Muraenesex cinereus	LRnt
Muraenichthys schultzei	VU
Plotosidae	
Plotosus canius	LRnt
Polynemidae	
Polynemus indicus	LRnt
Pomadasydae	
Pomadasys hasta	LRnt
Sciaenidae	
Otolithus ruber	LRnt
Serranidae	

Taxon	IUCN
Epinephelus tauvina	LRnt
Siganidae	
Siganus canaliculatus	LRnt
Siganus javus	LRnt
Sillaginidae	
Sillago sihama	LRnt
Sphyraenidae	
Sphyraena barracuda	LRnt
Teraponidae	
Therapon jarbua	LRnt
Therapon puta	LRnt
Trygonidae	
Dasyatis uarnak	VU
Trypauchenidae	
Trypauchen vagina	LRnt

Table 14. Basis for criteria for threatened fishes

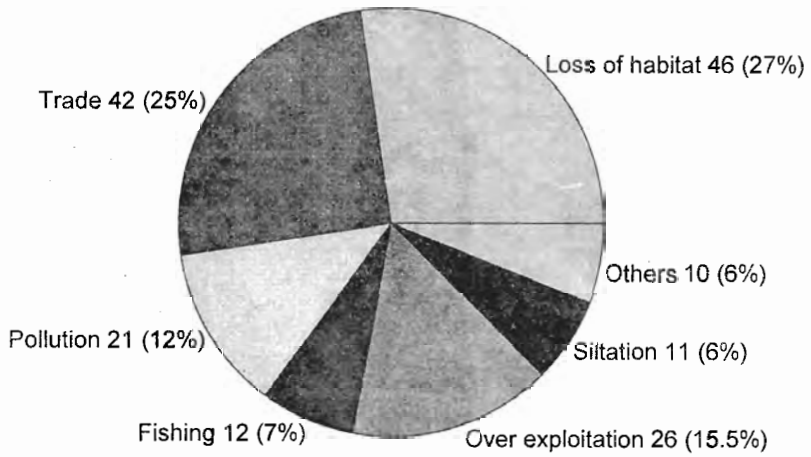
Taxon	IUCN	Assessed for	Threatened due to	Criteria
Alectis indicus	LR-nt	E. & W. coastal waters	—	—
Ambassis commersoni	LR-nt	E. & W. coastal waters	—	—
Anguilla bicolar	LR-nt	E. & W. coastal waters	—	—
Anodentestoma chacunda	LR-nt	E. & W. coastal waters	—	—
Arius subrostratus	VU	E. & W. coastal waters	Population reduction	A1a,1c,1d
Boleophthalmus boddari	VU	E. & W. coastal waters	Population reduction	A1a, 1c, 2c
Boleophthalmus dussumieri	EN	W. coastal waters	Restricted distribution	B1, 2c
Carangoides ciliarius	LR-nt	E. & W. coastal waters	—	
Caranx ignobilis	LR-nt	E. & W. coastal waters	—	—
Caranx sexfasciates	LR-nt	E. & W. coastal waters	—	—
Chanes chanes	LR-nt	E. & W. coastal waters	—	—
Dasyatis uarnak	VU	E. & W. coastal waters	Restricted distribution	B1, 2e
Elopes machnata	VU	E. & W. coastal waters	Population reduction	A1a, 1c, 1d
Epinephelus tauvina	LR-nt	E. & W. coastal waters	—	—
Etroplus suratensis	LR-nt	E. & W. coastal waters	—	—
Glassogobius giurus	LR-nt	E. & W. coastal waters	—	—
Hilsa kelee	LR-nt	E. & W. coastal waters	—	—
Lates calcarifer	LR-nt	E. coastal waters	—	—
Leiognathus splendens	VU	E. & W. coastal waters	Population reduction	A1b, 2b
Lethrenus nebulosus	LR-nt	E. & W. coastal waters	--	--
Liza dussumieri	LR-nt	E. & W. coastal waters	—	—
Liza macrolepis	LR-nt	E. & W. coastal waters	—	—
Liza parsia	LR-nt	E. & W. coastal waters	—	—
Lobotes surinamensis	LR-nt	E. & W. coastal waters	—	—
Lutjanus argentimaculatus	LR-nt	E. & W. coastal waters	—	—
Lutjanus fulviflammus	LR-nt	E. & W. coastal waters	—	—
Lutjanus johni	LR-nt	E. & W. coastal waters	—	—
Lutjanus russelli	LR-nt	E. & W. coastal waters	—	—
Lutjanus sebae	LR-nt	E. & W. coastal waters	—	—
Megalops cyprinoides	LR-nt	E. & W. coastal waters	—	—
Mugil cephalus	LR-nt	E. & W. coastal waters	—	—
Muraena macrura	LR-nt	E. & W. coastal waters	—	—
Muraenesex cinereus	LR-nt	E. & W. coastal waters	—	—
Muraenichthys schultzei	VU	E. & W. coastal waters	Restricted distribution	B1,2c
Nematalosa nasus	LR-nt	E. & W. coastal waters	—	—
Osteomugil cunensius	LR-nt	E. & W. coastal waters	—	—
Otolithus ruber	LR-nt	E. & W. coastal waters	—	—
Periophthalmus koelreuteri	VU	E. & W. coastal & estuarine waters	Population reduction	A1a, 1c
Plotosus canius	LR-nt	E. & W. coastal waters	—	—
Pomadasys hasta	LR-nt	E. & W. coastal waters	—	—
Polynemus indicus	LR-nt	E. & W. coastal waters, A & N Is.	—	—

Taxon	IUCN	Assessed for	Threatened due to	Criteria
Psammaperca waigaensis	VU	E. & W. coastal waters	Population reduction	A1a, 1c, 1d
Scartelaos viridis	EN	E. & W. coastal waters	Population reduction, Restricted distribution	A1a, 1c,B1,2c
Secutor ruconius	VU	E. & W. coastal waters	Population reduction	A1a, 2b
Siganus canaliculatus	LR-nt	E. & W. coastal waters	—	—
Siganus javus	LR-nt	E. & W. coastal waters	—	—
Sillago sihama	LR-nt	E. & W. coastal waters	—	—
Sphyraena barracuda	LR-nt	E. & W. coastal waters	—	—
Tenualosa ilisha	LR-nt	E. & W. coastal waters	—	—
Therapon jarbua	LR-nt	E. & W. coastal waters	—	—
Therapon puta	LR-nt	E. & W. coastal waters	—	—
Trypauchen vagina	LR-nt	E. & W. coastal waters	—	—

Threats

Since all the assessed fishes are dependent on mangroves for breeding, loss of mangrove habitat is a major threat to marine fishes. Trade is an important threat because of unsustainable and unscientific fishery practices which leads to over exploitation. Siltation in the mangroves and extensive use of pesticides upstream has led to the deterioration of the mangrove habitat for fishes. The figure below and table 12 show the kinds of threats affecting marine fishes.

Threats affecting marine fishes



Number of marine fishes assessed = 52
Number of threatened marine fishes = 11

Table 15. Threats to marine fishes

SPECIES	THREATS	IUCN
Alecits indicus	Fishing, Pollution, Trade(L)	LRnt
Ambassis commersoni	Loss of habitat, Pollution	LRnt
Anguilla bicolor	Damming, Loss of habitat, Pollution, Trade (D)	LRnt
Anodentestoma chacunda	Fishing, Loss of habitat, Trade (L)	LRnt
Arius subrostratus	Loss of habitat, Over exploitation, Pollution, Trade (L, D, C)	VU
Boleophthalmus boddari	Loss of habitat, Pollution	VU
Boleophthalmus dussumieri	Loss of habitat, Pollution	VU
Carangoides ciliarius	Loss of habitat, Over exploitation, Pollution, Trade (C, D)	LRnt
Caranx ignobilis	Fishing, Loss of habitat, Trade (L)	LRnt
Caranx sexfasciates	Loss of habitat, Over exploitation, Trade (L, I)	LRnt
Chanos chanos	Fishing, Loss of habitat, Over exploitation, Trade (L)	LRnt
Dasyatis uarnak	Fishing, Human interference, Trade (L)	VU
Elopes machnata	Fishing, Loss of habitat, Pollution, Trade (L)	VU
Epinephelus tauvina	Loss of habitat, Over exploitation, Trade (L,I)	LRnt
Etroplus suratensis	Loss of habitat, Over exploitation, Trade (L)	LRnt
Glassogobius giurus	Damming, Loss of habitat, Trade (D)	LRnt
Hilsa kelee	Damming, Loss of habitat, Over exploitation, Pollution, Trade (L)	LRnt
Lates calcarifer	Fishing, Loss of habitat, Trade (L,I)	LRnt

SPECIES	THREATS	IUCN
Leiognathus splendens	Over exploitation, Trade (L)	VU
Lethrenus nebulosus	Loss of habitat, Over exploitation, Trade (L,I)	LRnt
Liza dussumieri	Loss of habitat, Over exploitation, Pollution, Siltation, Trade (L)	LRnt
Liza macrolepis	Loss of habitat, Over exploitation, Pollution, Trade (L)	LRnt
Liza parsia	Loss of habitat, Over exploitation, Pollution, Siltation, Trade (L)	LRnt
Lobotes surinamensis	Loss of habitat, Over exploitation, Trade (L)	LRnt
Lutjanus argentimaculatus	Loss of habitat, Over exploitation, Trade (L,I)	LRnt
Lutjanus fulviflammus	Loss of habitat, Over exploitation, Siltation, Trade (L,I)	LRnt
Lutjanus johni	Loss of habitat, Over exploitation, Siltation, Trade (L,I)	LRnt
Lutjanus russelli	Loss of habitat, Over exploitation, Trade (L,I)	LRnt
Lutjanus sebae	Loss of habitat, Over exploitation, Trade (L)	LRnt
Megalops cyprinoides	Loss of habitat, Pesticides, Pollution, Siltation	LRnt
Mugil cephalus	Loss of habitat, Over exploitation, Pollution, Siltation, Trade (L)	LRnt
Muraena macrura	Loss of habitat, Pesticides, Pollution, Siltation, Trade(L)	LRnt
Muraenesex cinereus	Loss of habitat	LRnt
Muraenichthys schultzei	Loss of habitat, Pollution	VU
Nematalosa nasus	Loss of habitat, Siltation, Trade (L)	LRnt
Osteomugil cunensius	Loss of habitat, Over exploitation, Trade (L)	LRnt
Otolithus ruber	Loss of habitat, Over exploitation, Trade (L,I)	LRnt
Periophthalmus koelreuteri	Loss of habitat, Pollution	VU
Plotosus canius	Loss of habitat, Pollution, Trade (L)	LRnt
Pomadasys hasta	Fishing, Loss of habitat, Trade (L)	LRnt
Polynemus indicus	Loss of habitat, Over exploitation, Pollution, Siltation, Trade (L, I)	LRnt
Psammaperca waigaensis	Fishing, Loss of habitat, Pollution, Trade (L)	VU
Scartelaos viridis	Loss of habitat	EN
Secutor ruconius	Over exploitation	VU
Siganus canaliculatus	Loss of habitat, Over exploitation, Siltation	LRnt
Siganus javus	Loss of habitat, Siltation, Trade (L)	LRnt
Sillago sihama	Loss of habitat, Over exploitation, Trade (L)	LRnt
Sphyraena barracuda	Fishing, Loss of habitat, Predation, Trace (L)	LRnt
Tenualosa ilisha	Damming, Loss of habitat, Over exploitation, Pollution, Trade (L)	LRnt
Therapon jarbua	Human interference, Loss of habitat, Trade (L)	LRnt
Therapon puta	Fishing, Human interference, Loss of habitat, Trade (L, D)	LRnt
Trypauchen vagina	Fishing, Trade (L)	LRnt

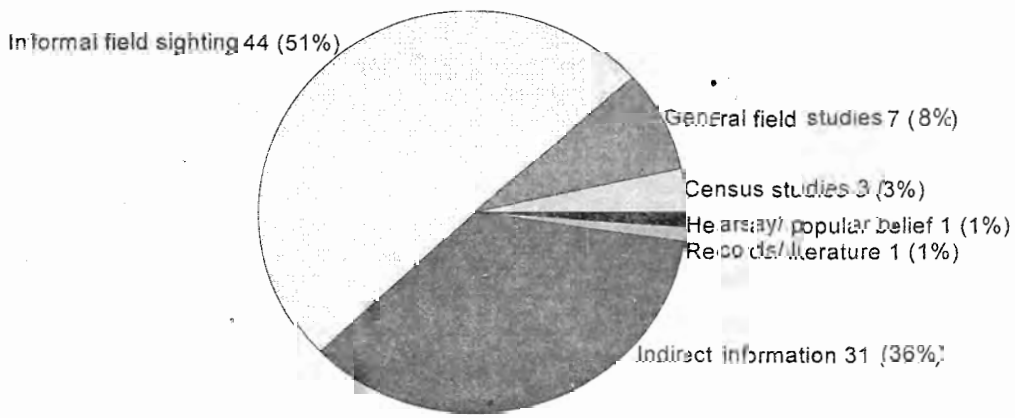
Data quality

Very little information is available about population distribution or dynamics of marine fishes. This is largely evident by the fact that -- in terms of data quality -- only 11% of data is through reliable censos and general field studies, while the rest is through informal field sightings and indirect information through fishery records from various governmental fishery institutes.

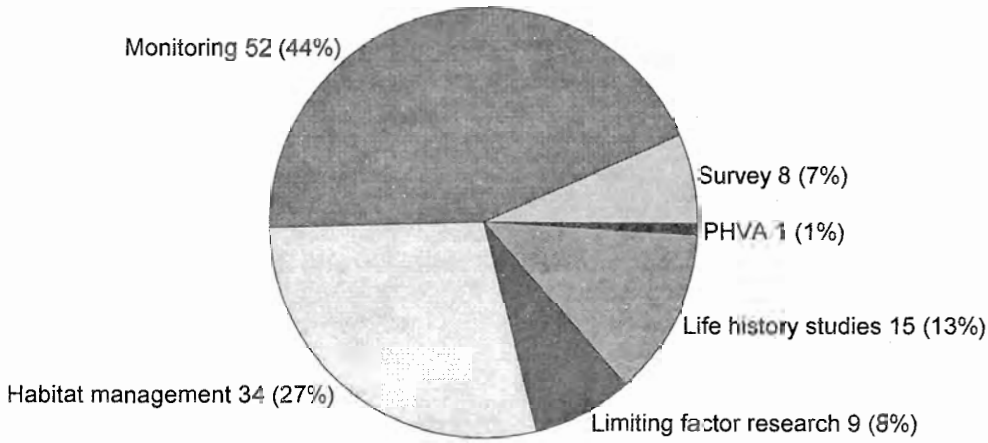
Recommendations

Monitoring is very highly recommended for management of marine fishes since no information is available on population trends and the effects of various threats both to the marine environment and the mangroves. Habitat management has been given a great deal of importance because of the degree of dependence fishes have on mangrove ecosystem and that any loss or damage to the ecosystem would be reflected in the population structure of fishes.

Data quality



Number of marine fishes assessed = 52



Number of marine fishes assesed = 52

Table 16. Research and management recommendations for fishes

	T	S	M	G	H	Hm	Lm	Lr	Lh	P	O
CR	-	-	-	-	-	-	-	-	-	-	-
EN	-	-	1	-	-	-	-	-	-	-	-
VU	-	5	10	-	-	2	-	-	4	1	-
LR-nt	-	-	39	-	-	30	1	10	10	-	-
LR-lc	-	-	-	-	-	-	-	-	-	-	-
DD	-	-	-	-	-	-	-	-	-	-	-
Total	0	5	50	0	0	32	1	10	14	1	0

Table 17. Captive breeding recommendations for marine fishes

Breeding	Level 1	Level 2	Level 3	Level 4	Pend.	No
CR	-	-	-	-	-	-
EN	-	-	-	-	-	1
VU	-	-	-	-	5	5
LRnt	2	1	6	11	2	20
LRlc	-	-	-	-	-	-
DD	-	-	-	-	-	-
Total	2	1	6	11	7	26

Table 18. Level of difficulty in breeding fishes in captivity

	Level 1	Level 2	Level 3	Unknown
CR	-	-	-	-
EN	-	-	-	2
VU	1	-	-	8
LRnt	5	10	5	21
LRlc	-	-	-	-
DD	-	-	-	-
Total	6	10	5	31

Captive breeding and level of difficulty

Captive breeding is not a recommendation for marine fishes because the popular feeling among the participants was that fish populations can recover from very low population densities and that a special effort in breeding them for conservation is not necessary.

The last group of taxa to be assessed at the mangrove workshop was invertebrates associated with the mangrove ecosystem. A total of 40 taxa were assessed, which included marine, terrestrial and arboreal forms.

Mangrove invertebrates

Table 19. Family-wise listing of mangrove invertebrates assessed at the workshop

Taxon	IUCN
Balanidae	
Balanus amphitrite	LRlc
Gecarcinidae	
Cardisoma carnifex	CR
Geloindae	
Geloina erosa	EN
Geometridae	
Gonodontis clelia	LRlc
Grpsidae	
Sesarma taeniolata	VU
Mytilidae	
Modiolus striatulus	LRnt
Perna viridis	LRnt
Noctuidae	
Atacira flaviluna	LRlc
Nymphalidae	
Polyura schreiber *	NE
Ocypodidae	
Dotilla myctiroides	LRnt
Macrophthalmus depressus	LRnt
Macrophthalmus convexus	EN
Uca dussumieri	LRnt
Uca lactea	LRnt
Uca tetragonon	EN
Uca vocans	LRnt
Ocypode ceratophthalma	LRnt
Ostreidae	
Crassostrea gryphoides	LRnt
Saccostrea cucullata	LRnt
Palaemonidae	
Metapenaeus dobsoni	LRnt

Taxon	IUCN
Penaeus caniliculatus	VU
Penaeus indicus	LRnt
Penaeus japonicus	VU
Penaeus merguiensis	LRnt
Penaeus monodom	LRnt
Penaeus semisulcaetus	LRnt
Pholadidae	
Martesia striata	LRlc
Portunidae	
Scylla serrata	LRnt
Saturniidae/ Lepiodoptera	
Attacus mcmulleni *	LRlc
Sphagomidae	
Sphaeroma terebrans	LRlc
Teredeinidae	
Nausitora dunlopei	LRlc
Bactronophorus thoracites	LRlc
Bankia campanellata	LRlc
Bankia carinata	LRlc
Bankia rochi	LRlc
Lyrodus pedicellatus	LRlc
Nausitora hedleyi	LRlc
Dicyathifer manni	LRlc
Thalassinidae	
Thalassina anomala	LRnt
Veneridae	
Meretrix casta *	VU
Xanthidae	
Pilodius nigrocrinitus	EN

Table 20. Basis for assessment of mangrove invertebrates

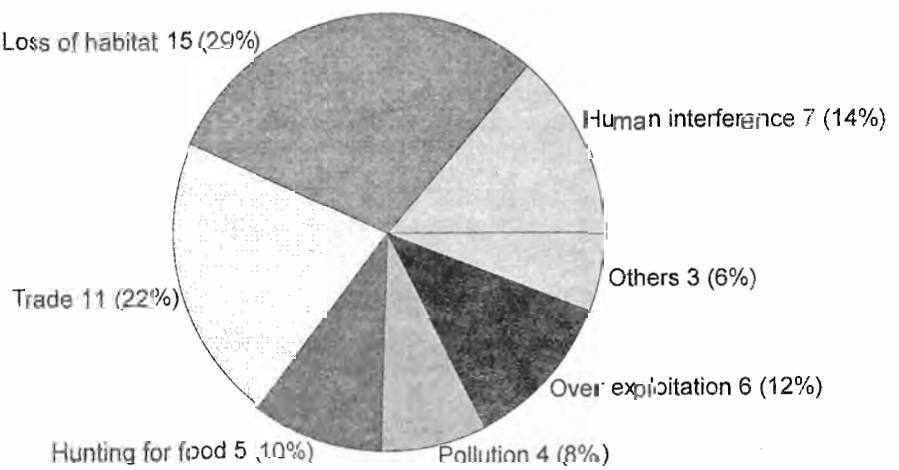
Taxon	IUCN	Assessed for	Criteria	Subcritera
Atacira flaviluna	LRlc	A & N Is.	--	--
Attacus mcmulleni	LRlc	A & N Is.	--	--
Bactronophorus thoracites	LRlc	E. coast, A & N Is.	—	—
Balanus amphitrite	LRlc	E. & W. Coast & Is.	—	—
Bankia campanellata	LRlc	E. & W. coast	—	—
Bankia carinata	LRlc	E. & W. coast	—	—
Bankia rochi	LRlc	E. & W. coast, A & N Is.	—	—
Cardisoma carnifex	CR	E. coast, A & N Is.	Restricted distribution	B1, 2c
Crassostrea gryphoides	LRnt	E. & W. coast, A & N Is.	Unknown	Unknown
Dicyathifer manni	LRlc	E. & W. coast, A & N Is.	—	—
Dotilla myctiroides	LRnt	E. & W. coast, A & N Is.	—	—
Geloina erosa	EN	E. & W. coast	Restricted distribution	B1, 2c
Gonodontis clelia	LRlc	A & N Is.	—	—
Lyrodus pedicellatus	LRlc	E. & W. coast, A & N Is.	—	—
Macrophthalmus depressus	LRnt	E. & W. coast, A & N Is.	—	—
Macrophthalmus convexus	EN	E. & W. coast, A & N Is.	Restricted distribution	B1, 2c
Martesia striata	LRlc	E. & W. coast, A & N Is.	—	—
Meretrix casta	VU	E. & W. coast	Population reduction	A1, 1c , 1d

Taxon	IUCN	Assessed for	Criteria	Subcritera
Metapenaeus dopsoni	LRnt	E. & W. coast, A & N Is.	—	—
Modiolus striatulus	LRnt	E. & W. coast, A & N Is.	—	—
Nausitora dunlopei	LRlc	E. & W. coast, A & N Is.	No	No
Nausitora hedleyi	LRlc	E. & W. coast, A & N Is.	—	—
Ocypode ceratophthalma	LRnt	E. & W. coast & Is.	—	—
Penaeus canaliculatus	VU	E. & W. coast	Restricted distribution	B1, 2c
Penaeus indicus	LRnt	A & N Is.	—	—
Penaeus japonicus	VU	E. & W. coast	Restricted distribution	B1, 2c
Penaeus merguiensis	LRnt	W. coast, A & N Is.	—	—
Penaeus monodom	LRnt	E. & W. coast, A & N Is.	—	—
Penaeus semisulcaetus	LRnt	E. & W. coast	—	—
Perna viridis	LRnt	E. & W. coast, A & N Is.	—	—
Pilodius nigrocrinitus	EN	E. coast, A & N Is.	Restricted distribution	B1, 2c
Polyura schreiber	NE	A & N Is.	No	No
Saccostrea cucullata	LRnt	E. & W. coast, A & N Is.	—	—
Scylla serrata	LRnt	E. & W. coast, A & N Is.	—	—
Sesarma taeniolata	VU	E. & W. coast, A & N Is.	Restricted distribution	B1, 2c
Sphaeroma terebrans	LRlc	E. & W. coast, A & N Is.	—	—
Thalassina anomala	LRnt	E. & W. coast, A & N Is.	—	—
Uca dussumieri	LRnt	E. & W. coast, A & N Is.	—	—
Uca lactea	LRnt	E. & W. coast, A & N Is.	—	—
Uca tetragonon	EN	A & N Is.	Restricted distribution	B1, 2c
Uca vocans	LRnt	E. coast, A & N Is.	—	—

Threats

Nine of the 42 invertebrates were assessed as threatened. Taxa that are threatened are so due to loss of habitat, human interference, trade and over exploitation Many of the invertebrate taxa taken up at the workshop, however, are without any threats and therefore came into non-threatened categories Table 17 indicates the different types of threats affecting invertebrate taxa in mangroves.

Threats to mangrove invertebrates



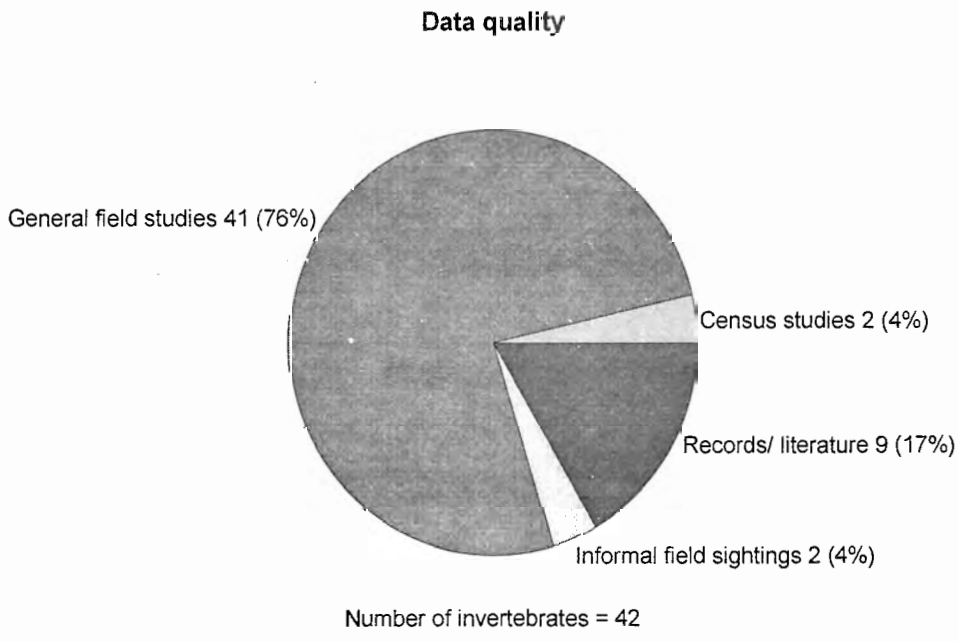
Number of invertebrates assessed = 42
Number of threatened invertebrates = 9

Table 21. Threats affecting mangrove invertebrates

Taxon	Threats	IUCN
Atacira flaviluna	No	LR-lc
Attacus mcmulleni	No	LR-lc
Bactrophorus thoracites	No	LR-lc
Balanus amphitrite	No	LR-lc
Bankia campanellata	No	LR-lc
Bankia carinata	No	LR-lc
Bankia rochi	No	LR-lc
Cardisoma carnifex	Loss of habitat	CR

Taxon	Threats	IUCN
Crassostrea gryphoides	Harvest for food, Trade (L)	LR-nt
Dicyathifer manni	No	LR-lc
Dotilla myctiroides	Human interference, Pollution	LR-nt
Geloina erosa	Harvest for food, Loss of habitat, Trade (L)	EN
Gonodontis clelia	No	LR-lc
Lyrodus pedicellatus	No	LR-lc
Macrophthalmus depressus	Loss of habitat	LR-nt
Macrophthalmus convexus	Loss of habitat	EN
Martesia striata	No	LR-lc
Meretrix casta	Loss of habitat, Over exploitation, Trade (C, L, D)	VU
Metapenaeus dopsoni	Over exploitation, Trade (L, I)	LR-nt
Modiolus striatulus	Human interference, Loss of habitat	LR-nt
Nausitora dunlopei	No	LR-lc
Nausitora hedleyi	No	LR-lc
Ocypode ceratophthalma	Human interference, Pollution	LR-nt
Penaeus caniliculatus	Climate	VU
Penaeus indicus	Over exploitation, Trade (L, I)	LR-nt
Penaeus japonicus	Climate	VU
Penaeus merguiensis	Over exploitation, Trade (L, I)	LR-nt
Penaeus monodom	Disease, Over exploitation, Trade (L, I)	LR-nt
Penaeus semisulcaetus	Over exploitation, Trade (L)	LR-nt
Perna viridis	Harvest for food, Pollution, Trade (L)	LR-nt
Pilodius nigrocrinitus	Human interference, Loss of habitat	EN
Polyura schreiber	Loss of habitat	NE
Saccostrea cucullata	Harvest for food, Trade (L)	LR-nt
Scylla serrata	Harvest for food, Loss of habitat, Pollution, Trade (C, L, D, I)	LR-nt
Sesarma taeniolata	Human interference, Loss of habitat	VU
Sphaeroma terebrans	No	LR-lc
Thalassina anomala	Human interference, Loss of habitat	LR-nt
Uca dussumieri	Loss of habitat	LR-nt
Uca lactea	Loss of habitat	LR-nt
Uca tetragonon	Human interference, Loss of habitat	EN
Uca vocans	Loss of habitat	LR-nt

Data Quality



Recommendations

Monitoring and Survey have been suggested as priority research and management recommendations due to lack of knowledge about population distribution, dynamics or threats affecting mangroves and invertebrates. Captive breeding has been recommended for only 1 taxon for conservation while 9 taxa have been recommended for captive breeding for sustainable utilisation. For most of the taxa, the participants did not have any information on the level of difficulty in breeding invertebrates in captivity.

Table 22. Research and management recommendations for mangrove invertebrates

	T	S	M	G	H	Hm	Lm	Lr	Lh	P	O
CR	-	1	1	-	-	-	-	-	1	1	-
EN	-	4	4	-	1	-	-	-	1	1	-
VU	-	3	2	-	3	1	-	-	1	-	-
LR-nt	-	7	12	4	9	-	-	-	-	-	-
LR-lc	-	3	14	-	-	-	-	-	2	-	-
DD	-	-	-	-	-	-	-	-	-	-	-
NE	1	1	1	-	-	-	-	-	1	1	-
Total	1	19	34	4	13	1	0	0	6	3	0

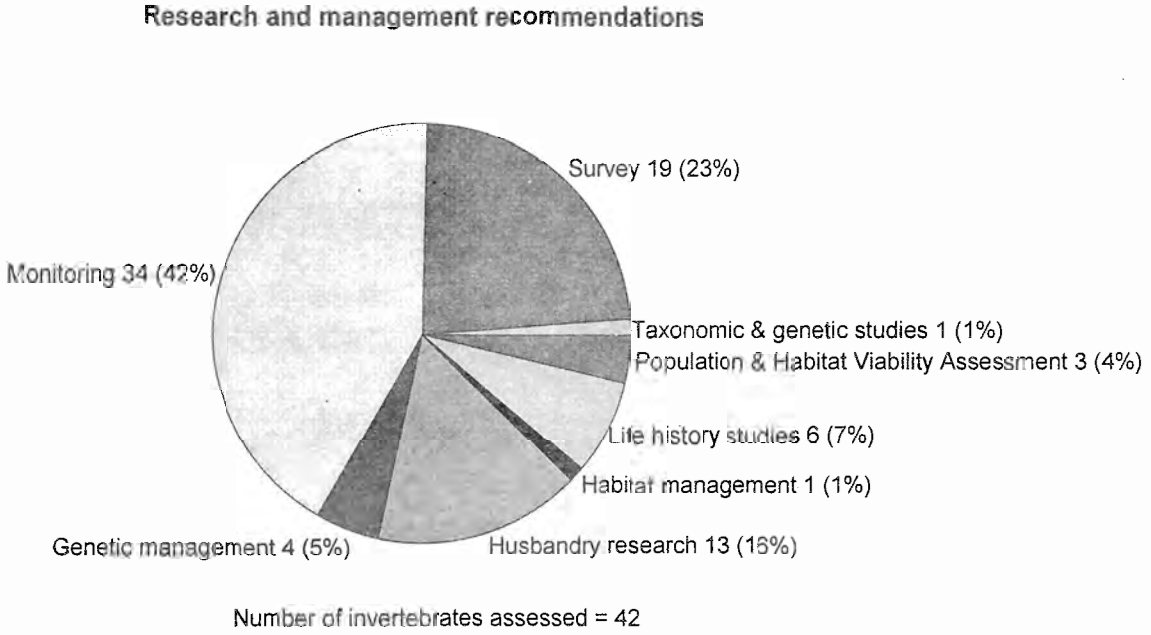


Table 23. Captive breeding recommendation for invertebrates

Breeding	Level 1	Level 2	Level 3	Level 4	Pend.	No
CR	-	-	-	-	-	1
EN	-	-	-	1	1	2
VU	-	-	-	3	1	-
LRnt	1	-	-	5	-	-
LRlc	-	-	-	-	8	9
DD	-	-	-	-	-	5
Total	1	0	0	9	10	17

Table 24. Level of difficulty in breeding invertebrates in captivity

Level of difficulty	Level 1	Level 2	Level 3	Unknown
CR	-	-	-	-
EN	-	-	1	3
VU	1	1	1	1
LRnt	3	2	1	12
LRlc	-	-	-	13
DD	-	-	-	-
NE	-	-	-	1
Total	4	3	3	30

Special Issue Working Groups

Special working groups were formed at the workshop to discuss issues of importance in the context of assessing and conserving the mangrove ecosystem. Four groups were formed for the following subjects 1. Invertebrates, 2. Marine fishes, 3. IUCN Red List criteria and 4. Marine algae. The working group reports are presented below.

Invertebrates Working Group

Members: B.A. Daniel, A.K. Das, S.N. Harkantra, A. Kutty, B. Ingole, P. Mohanaraj, R.M. Sharma.

The mangrove ecosystem being the interphase between terrestrial forests and aquatic (marine) ecosystems, it includes diversified macrohabitats such as mangrove dominated forests, litter laden forest floors, mudflats, adjacent coral reefs (in Andaman and Nicobar islands) and contiguous water courses which may be rivers, bays, intertidal creeks and channels and, backwaters. Thus, this ecosystem offers innumerable microhabitats for a large number of invertebrate species.

About 500 species of invertebrates have been reported from Indian mangroves out of which little more than 50% are insects and 20 % are zooplankton species. Amongst the remaining, molluscs and crustaceans are dominated (45%) in number of species followed by polychaetes. The majority of insect fauna reported so far are visitors. However, very recently (Veenakumari, *et al.*, 1997) reported the occurrence of 276 species of insects from the mangals of Andaman and Nicobar Islands out of which 197 species are herbivores, 36 species are predators and 43 species of parasitoides. Since only localized data of these insects are available these were not considered for assessment.

We have concentrated mainly on the assessement of resident animals which, almost exclusively spent their adult life in the mangals. Besides, we have also generated enormous data on economically important shell fishes where enough data are available.

Fishes Working Group Report

Members: M. Borkar, R.S. Lalmohan, P. Jeyaseelan, A. Kumar, P. Nammalvar, D. Parulekar, N. Rajendran, K.M. Panaisivam, A. Ramesh

In recent years, there is a global awarness for increased fish production under capture and culture conditions of coastal waters, estuaries, backwaters and mangrove swamps which constitute one of the most valuable and vulnerable natural resources of a nation's economy. The biodiversity of the various finfish species in the above ecosystems affects the natural resources. The following finfish species are included in the Lower risk - near threatened category.

Carangoides ciliarius Gunther, *Dasyatis uarnak* (Forsskal), *Hilsa kelee* (Cuvier), *Liza dussumieri* [=*L. subviridis* (Valenciennes)], *Liza macrolepis* (Smith), *Liza parsia* Hamiltens & Buchanan *Lutjanus fulviflammus* (Forsskal), *Lutjanus seleae* (Cuvier), *Lutjanus russelli* (Bleeker), *Megalops cyprinoides* (Broussonet), *Mugil cephalus* Linnaeus, *Osteomugil cunensius* (Valenciennes), *Plotosus canius* (Ham & Buch), *Pomadasys hasta* Bloch, *Sillago sihama* (Forsskal), *Siganus canaliculatus* (Linnaeus), *Siganus javus* (Linneaus), *Therapon puta* Cuvier, *Trypauchen vagina* (Bloch & Schneider).

Based on the finfish catch data, information on the loss of mangrove habitat due to human activities and over- exploitation of the stocks during seasons, it may be inferred that the distribution and abundance of finfish species were altered in the natural habitat. Before coming to the conclusion the rate of decline, reasons of decline, status of the habitat both quality and quantity were taken into consideration. Most of the species show a declining trend though we don't have specific data on each species. In fact we have data on the groups only, as perches or groupers or shads. However these data indicate the reduction of catch and the general trend.

Population monitoring and the life history studies should be done and will be important for the days to come.

The following finfish species are included in the Lower risk- least concern category:
Alectis indicus (Ruppell), *Ambassis commersoni* (Cuvier), *Caranx ignobilis, Caranx sexfasciates* Linneaus, *Etroplus suratensis* (Bloch), *Glassogobius giurus* (Hamilton-Buchanan), *Lethrenus nebulosus* (Forsskal), *Lobotes surinamensis* (Bloch), *Muraena macrura* (Bleeker), *Nematalosa nasus* (Bloch), *Sphyraena barracuda* (Walbaum), *Therapon jarbua* (Forsskal)

The above species are included in the LR-lc category as they have large area of distribution along the east and west coast of India and having global distribution extending from the east coast of Africa to Pacific coast. Some of them are transient population in the mangroves visiting the areas for feeding. Some of them form a fishery of local importance in trawlers and gillnets. Here also we have no specific data on the species. As a whole these data do not give indication of general decline though the personal perception of individual workers have shown decline to some extent. The general decline of many species may also be due to over exploitation. As management measures, the mesh size regulation in the capture of the many finfish species are to be imposed. This may avoid the species and number reduction on the fishery. Only medium size fishes are to be caught leaving the mature and early juveniles of the individual species in the natural habitat so as to maintain the stable populations.

Recommendations.

1. Before the construction of dams, environmental impact assessment should be made in the content of fisheries. The down stream impact of the rivers should also be studied as it is related to silt load of the rivers which is critical for the nutrient cycle.
2. Before the introduction of the new craft and gear their impact on fish populations should be verified.
3. The source of pollution and their impact on the fish habitat are to be assessed.
4. There should be regulation on the capture of juvenile in the mangrove areas. Regular monitoring studies should be undertaken
5. Habitat enhancement schemes such as regulation and replanting of mangroves flow of water methods for capture fishes should be considered.

The following finfish species are coming under VU.
Anguilla bicolar McClellandi, *Arius subrostratus* Valenciennes, *Boleophthalmus boddari* Cuvier, *Boleophthalmus dussumieri* Cuv. & Val., *Chanos chanos* (Forsskal), *Leiognathus splendens* (Cuvier), *Muraenichthys schultzei* (Bleeker), *Peripothalmus koelreuteri, Secutor ruconius* Ham & Buch, *Psammaperca waigaensis* (Cuvier), *Tenualosa ilisha* Ham.-Buch., *Elopes machnata* (Forsskal)

The above species are treated as vulnerable as their population has delivered in many areas mainly due to human disturbance like overfishing, dams, pollution, etc. Here also we may not have specific data on the species. But overall perception indicates decline in the fishery. For some of the species their distribution is fragmented while for some, dams and pollution form limiting factors. Environment impact assessment is required for the decline. Indiscriminate catch of larvae and juveniles is one of the important factors which affects the population. *Chanos chanos* and *Elops* population have declined mainly due to the over-exploitation of the juveniles which come to the coastal, mangrove and mudflats for feeding. *Chanos* which formed a fishery has just vanished along the Indian coast. The decline is well-documented. Before 40 years there was regular fry collection in Pamban and Rameshwaram, along the south-east coast. Now this fishery has been totally disappeared. Dams have done great harm to the hilsa fishery. *Hilsa ilisha* population has greatly declined due to

large dams. Dams also block the sediment load to the mangrove. But very little attention is paid. Farakka Barrage and Mettur dams have caused great harm to the mangoves. Over fishing also have caused harm.

The following finfish species are coming under EN.
Boleophthalmus viridis, *Hamilton* Buchanon.

The major reasons for categorising this species as EN are its restricted range, being a resident of mangrove habitat, fragmentation of its habitat, and past and expected decline in the area and quality of habitat. Even though there is no quantitative data, some of the group members felt that there has been a drastic decline in the population in the last decade. The reasons cited in the vulnerable section also apply here also. Perhaps more detailed investigation may bring to light more species under this category.

Comments on IUCN Criteria Working Group
Members: L.J. Bhosale, S. Deshmukh, H.S. Kanvinde, K. Kathiresan, A.G. Untawale, S. Wafar, S.R. Yadav.

The Working Group felt that although the IUCN criteria laid down for the assessment of data sheet (on page 11 of the *Reference Manual,* 2nd Ind.Ed.), is quite comprehensive and well prepared, it, however, requires some modifications while systematically applying it to mangrove species. The Working Group discussed the following parameters of difficulty and tried to form a general consensus about the range and scope of difficulties in applying the criteria to mangrove species.

1. The Working Group felt that in general the following parametres used in the Red List categories have more applicability for animal groups; Extent of occurrence (A B C D); Area of occupancy (A B C D); Locations - For continuous, Population trends, World population, Generation time, Regional population/ distribution; Application of Red data Book (Red list) categories
2. The Working Group felt that an "ecosystem specific" sheet could be developed, particularly for the special group of plants "mangroves" which have:
    i) Restricted distribution (Geographical)
    ii) Almost uniform habitat
    iii) Almost uniform ecosystem
    iv) Limited number of species (limited diversity of species)
    v) Exposed to almost same types of threats continuously
    vi) Difficulty in their regeneration/propagation

3. The Working Group found that while filling up the data sheet forms, some species such as *Acanthus ilicifolius, Clerodendrum inerme, Avicennia marina* var. *acutissima* which are quite common along the coast, came under 'Critically Endangered or Endangered' categories based on the IUCN categories. This may not be the correct projection of these species in reality.
4. The Working Group therefore feels that the present categories need modification with reference to plants such as mangroves.
5. The Working Group also felt that the fact about the meagre/inadequate present knowledge of the plant species particularly the 'Mangroves' which are inadequately explored, cannot be neglected while practicaly applying the IUCN categories for assessment of the species.

Marine Algae Working Group
Members: A.G. Untawale, V.K. Dhargalkar, T.G. Jagtap, G.V. Deshmuke.

Altogether 624 species of marine macro-algae occur along the Indian coast. In India, forty-eight marine algal species are reported from the mangrove swamps. In our Working Group, however, we restricted ourselves to 25 macro algal species. These algae belong to 3 major groups such as Chlorophyta - green algae; Phaeophyta - brown algae and Rhodophyta - red algae. Mangrove regions in the tropics have been observed to harbor a number of economically/ commercially important algae such as *Monostroma oxyspermum* (high nutritional value), *Gracilaria verrucosa* (agarophyte), *Catnella impudica, Caloglossa lepriurii* (dyes and food vale) and *Caulerpa* sp. (bioactive substance), etc.

Species like *Enteromorpha clathrata* is most common on both east and west coast region. It has been observed that number of researchers working on the mangrove ecosystem in India have not paid much attention to work out ecological significance of these algae in mangrove ecosystem.

Marine algae in the mangrove swamps contribute in two ways; the first is towards the detritus and second is providing food for molluscs and other crustaceans. The association of the algae and fauna in mangrove area has yet to be studied.

The marine algal distribution in this region, along the Indian coast has so far been restricted to the taxonomical level, i.e. taxonomic identification and geographical occurrence. Actual availability of these species (in terms of biomass) still remains doubtful. Some estuaries along Central west coast of India are studied extensively by Jagtap and Untawale *et al.* However, from the east coast meager data is available (except for Sunderban) the species are mentioned along with the open coast intertidal algae; some times without monitoring the habitat. The third problem we faced during the assessment is that some of the species are present on the open coast as well in mangrove area. Therefore, while assessing and to give status, an error might have occurred.

Thus we feel that more systematic study is required to project a correct picture of marine algae in the mangrove swamps. Some species *Cladophora* and *Rosenvingea* should be investigated for the species level. It would be worth investigating role of marine algae in the mangrove food chain. This should be given priority. Similarly, it is required to work out the economics of commercially important algae.

Mangrove environment provides ideal location to undertake the seaweed cultivation studies for economically important seaweed species such as *Monostroma* and *Gracilaria* as wave action is minimized. A number of mangrove regions in the countries in southwest Asia have been used for the cultivation of economically important algae.

Conclusion
Participants at the workshop were strong in their belief that that mangrove ecosystem conservation is much required. The BCPP Conservation Assessment workshop has helped in understanding the urgent need to protect threatened taxa from extinction and manage them in the near future. Some of these taxa and the entire ecosystem may not survive if timely action is not taken, that is if they are not man-managed. Many of them, because of their small population size and restricted distribution, require intensive care and habitat management and may survive only with human support.

TAXON DATA SHEETS

This Report is incomplete without the Taxon Data Sheets and the Summary Data Table. A Taxon Data Sheet is one were in information regarding the species is included as given by the participants at the workshop. *Information* includes (as given in the example below) details about species distribution, threats to the habitat, threats to the population, population trends, number of individuals and other important information i.e., require to derive the threat category. For every species, data quality index is also provided to distinguish the kind of information gathered at the workshop, be it through scientific field study, records, indirect information or popular belief. Finally, the Taxon Data Sheets also includes recommendation for research and management action for every species as suggested by participants, which is the outcome of the CAMP process. A Taxon Data Sheet is filled for everyone of the 176 taxa assessed at the workshop, making it a treasure-trove of information on all Mangrove Ecosystem in India, in a single source.

We are unable to publish the two due to their length as they are too long for ZOOS' PRINT. Persons interested in a complete report may write to ZOO/CBSG, India and order it for Rs. 325 (Indians and equavalent for other Asian countries) and $ 35.00 for people from development countries.

***Salicornia brachiata* Roxb. — LRnt/N — Family:** Chenopodiaceae. **Taxonomic status:** Species. **Habit:** Herb. Erect or decumbant, Succulent stem, much branched, elevated saline blanks and mud flats. **Habitat:** Proestuarine. Downstream, Intermediate. Associate. **Global Distribution:** Indo-malaysia, India, Sri Lanka. South west Asia. **Current Regional Distribution:** East and west coast of India. **-Range (sq. km):** < 20,000. **-Area Occupied (sq. km):** < 2,000. **- Number of location**: Many. **Population Trends - % change: -% Decline:** 20 % (Projected increase 30 %) . **-Time / Rate (Yrs or gens):** (Over next 20 years). **- No of Mature Individuals:** Not known. **Global Population:** Not known. **Regional Population:** A projection in population increase has been cited over the next 20 years. **Data Quality:** General field studies; Informal field sightings (K.V. Billore, 1968-72 in Thane Dist., (Northern Maharashtra)). **Recent Field Studies:** T.A. Rao, 1960-97 in Coastal India. **Threats:** Climate; Edaphic factors; Fishing; Harvest for food; Loss of habitat; Pollution; Trade. **Trade:** Local; Domestic. **Other Comments:** Good formation in Tamil Nadu and less in west coast of India. Fleshy-sterns used as vegetable. **Status: -IUCN: LOWER RISK - NEAR THREATENED (Nationally). DATA DEFICIENT (Globally). -Criteria based on:** —. **-CITES:** No. **-IWPA(1972;91):** No. **-RDB National (1994):** No. **- RDB International (1996):** No. **Recommendations: -Research management:** Other (ecological studies). **-PHVA:** No. **Cultivation Program Recommendations: -Cultivation:** No. **-Level of difficulty:** Least difficult. **Existing Cultivation:** None. **-Names of facilities:** —. **Sourcers (Refer Appendix):** 19, 42, 45-60, 62-68, 70, 72-101, 103-145. **Compilers:** S. Wafar, M.R. Almeida, L.J. Bhosale, T.A. Rao, K.N. Desai, S. Deshmukh, C.N. Mohanan, S.R. Yadav, A.G. Untawale, A. Singh, K.V. Billore, R.K. Singh.

IUCN Red List Categories and Criteria explained in brief below

*** IUCN Red List *Categories:***

CR – Critically endangered -- a taxon is Critically endangered when it is facing an extremely high risk of extinction in the wild in the immediate future as defined by the criteria.

EN – Endangered -- a taxon is Endangered when it is not Critically endangered but is facing a very high risk of extinction in the wild in the near future as defined by the criteria.

VU – Vulnerable -- a taxon is Vulnerable when it is not Critically endangered or Endangered but is facing a high risk of extinction in the wild in the medium term future as defined by the criteria.

LR – Lower risk – a taxon is Low Risk when it has been evaluated and does not qualify for any of the threatened categories, Critically endangered, Endangered, Vulnerable, or Data Deficient. (LR-nt – near threatened, LR-lc –least concern, LR-cd – conservation dependent.

DD – Data deficient – A taxon is Data Deficient when there is inadequate information to make a direct or indirect assessment of its risk of extinction based on its distribution and/or population status.

NE – Not evaluated – A taxon is Not Evaluated when it has not yet been assessed against the criteria.

**** IUCN Red List *Criteria***

A – Population reduction – **(1)** observed, infered, suspected or estimated reduction, or **(2)** projected or predicted reduction of at least 20% (VU), or 50% (EN), or 80% (CR) in 10 years or 3 generations whichever is longer based on **(a)** Direct observation; **(b)** index of abundance appropriate for the taxon; **(c)** decline in areas of occupancy, extent of occurrence and/or quality of habitat; **(d)** actual or potential levels of exploitation; **(e)** effects of introduced taxa, hybridisation, pathogens, pollutants, competitors, or parasites.

B – Restricted distribution -- Extent of occurrence estimated to be less than 20,000 sq km. (VU), or 5,000 sq km (EN) or 100 sq km (CR) and/or area of occupancy estimated to be less than 2000 sq.km. (VU), or 500 sq km (EN), or 10 sq km (CR), and qualifying for any two of the following : **(1)** severely fragmented, or known to exist in not more than 10 locations (VU), or 5 locations (EN), or single location (CR); **(2)** continuing decline, observed, inferred, projected in any **(a)** extent of occurance, **(b)** area of occupancy; **(c)** area, extent and/or quality of habitat; **(d)** number of locations or subpopulations; **(e)** number of mature individuals; **(3)** extreme fluctuation in either **(a)** extent of occurance, **(b)** area of occupancy, **(c)** number of populations or subpopulations, **(d)** number of mature individuals.

C – Population estimates – population estimated to number less than 10,000 (VU), or 2,500 (EN), or 250 (CR) mature individuals and either **(1)** estimated, continuing decline of at least 10% in 10 years or 3 generations or whichever is longer (VU), or 20% in 5 years or 2 generations, whichever is longer (EN), or 25% in 3 years or 1 generation whichever is longer (CR) OR in **(2)** continuing decline, observed, projected, inferred, number of mature individuals and population structure in the form of either **(a)** severely fragmented [no subpopulation estimated to contain more than 1000 (VU), or 250 (EN), or 50 (CR) mature individuals] ; **(b)** all individuals are in a single subpopulation.

D – Restricted populations – **(1)** Population estimated to number less than 1000 (VU), or 250 (EN), or 50 (CR) mature individuals; **(2)** Population restricted in area of occupancy of less than 100 sq km or less than 5 locations (VU).

E – Probability of extinction – quantative analysis showing the probability of extinction in the wild is at least 10% in 100 years (VU), or 20% in 20 years or 5 generations, whichever is longer (EN), or 50% in 10 years or 3 generations, whichever is longer (CR).