

**Biodiversity Conservation and Livelihood Issues  
of Tribesfolk: A case study of Periyar Tiger Reserve**

**Arun L. K, Jayasankar B  
Kurian Mathew Abraham**

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**Kerala Research Programme on Local Level Development  
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# **Biodiversity Conservation and Livelihood Issues of Tribesfolk: A case study of Periyar Tiger Reserve**

Arun L. K., Jayasankar B., Kurian Mathew Abraham\*

## **1. Introduction**

The necessity of sustaining the biological diversity for maintaining the biosphere as a functioning system and of supporting the basic needs of mankind is amply exemplified in the literature. The development process worldwide which has resulted in large-scale destruction and conversion of natural habitats and ecosystems has become alarmingly rapid in recent times. This, among other things, has led to the concern that such biodiversity losses could threaten the sustainability of development itself. This is true in a global sense too, as persons deciding to convert their local environment do not consider the global costs of their action. On an economic perspective, the biodiversity problem requires the regulation of local development processes for the advancement of global interests (World Conservation Monitoring Centre, 1992). This issue has now been dominantly dealt with at the international as well as the local level.

Biodiversity, which is contraction of the term *biological diversity*, refers, in a broad sense, to species abundance, richness, and variety within the living world – plants, animals, and micro organisms – as well as to the ecosystems and ecological processes to which they belong. The maintenance of biological diversity at all levels is fundamentally the maintenance of viable or identifiable populations of species. Sometimes an ecosystem may tend to be driven by a small number of species, which is commonly referred as the critical or the key stone species. The loss of these critical species may tend to trigger fundamental transformation processes to an ecosystem. The great threat to biodiversity is a cause of concern mainly because of its direct as well as indirect contribution to society. The trade off between development dependence of man on biodiversity and its conservation has been the major issue in the conservation debate.

The significance of biodiversity conservation may be viewed in three ways. Firstly, biodiversity provides enormous direct economic benefits in the form of food, medicine, and industrial raw material and has the potential for generating many more (Ehrlich and Wilson,

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1991). This aspect is mostly local in nature. Secondly, it supplies an array of essential services to humanity such as clean air, modification of climatic extremes, degradation of wastes, recycling of nutrients, creating of soils, controlling of diseases, and regulating of hydrological cycles. Finally, the ethical and aesthetic values; i.e., plants and animals have intrinsic values that are independent of monetary valuations. Many species of wild animals and plants and the ecosystem, of which they are integral parts, are a source of irreplaceable wonder, spirituality, and inspiration to humanity (Ledec and Goodland, 1988).

The economic argument of protection of biodiversity stems from different concepts of value attached to it such as market values, ecosystem values, existence values, and intergenerational values. In the present market-driven systems, the concepts of existence and intergenerational values have gained hope for conservation.

One of the strategies by which biological systems are being conserved is the establishment of Protected Areas. But the designation of Protected Areas has often involved the abrogation of rights of access traditionally enjoyed by local populations. Thus the establishment of Protected Areas often creates direct conflict with the economic interests of local communities, as the conservation efforts are likely to affect their very existence. Consequent on the creation of Protected Areas, local communities have lost not just responsibility for managing the resources, but also are burdened with the indirect cost such as crop damage, loss of life, etc., caused by protecting wild animals. The situation has deteriorated in recent years with rising rural population and increasing poverty. Thus there always arise conflicts of interests between conservation and maintenance of livelihood of local communities.

Conflicting interests exist in most of the wildlife and national parks in India and are sought to be minimised by providing limited resource access to dependent communities. The arguments against providing access to local communities have been put down on grounds of 'traditional rights of the communities' and their 'source of primary livelihood'<sup>1</sup>. But the issue becomes complex when the notified area is a fragile ecosystem and resource exploitation becomes commercialised. This has been one of the main issues that policy makers and administrators face in recent times. These conflicting interests often thwart the conservation efforts. The trade off between these issues becomes difficult. In these situations, development of effective management options would call for assessment of the nature of dependence of the communities on protected biological resources and the rate of their exploitation of the resources.

Owing to the high population density, the pressure on forests from the people living within and in the fringes of forests is comparatively high in Kerala. The situation aggravates when resource exploitation becomes commercialised. This might, in the short run, help to increase the income of dependant communities, but in the long run, besides affecting the sustainability of the ecosystem, it would also deny to the future populations their right to enjoy the benefits of the ecosystem. Similar situations and issues exist in the Periyar Tiger Reserve in the Idukki district of Kerala, where tribal communities who had traditionally lived deep inside the forests and enjoyed the rights on the use of forest resources, were uprooted and relocated at the fringes for establishing the wildlife sanctuary. In return, the forest department allowed them to enjoy their traditional rights such as fishing, NTFPs collection, firewood

collection, etc. The sanctuary situated in the Western Ghats, is considered to be one of the mega biodiversity zones: it nests highly endemic, rare, and threatened flora, fauna and aquatic species. One of the resettled tribal groups, the *Mannans*, heavily depend on fishing in the lake for their livelihood. The issue arises because *Mannans* exploit the endangered and threatened fish species from the lake commercially, thereby creating conflicting interests between resource conservation and livelihood rights. The situation becomes more complex with the interaction of institutions supporting and resisting resource exploitation.

### **Objectives**

- (i) To elucidate the link between biodiversity conservation and local community development with reference to fisheries in Periyar Tiger Reserve
- (ii) To evaluate the degree of dependency of traditional tribal fishermen on the fish resources in relation to other income sources.
- (iii) To study the role of formal institutions involved in the development of commercial fisheries.

### **Approach to the present study**

The present study is organised on the following lines. Study area description and methodology of the study are presented in the second section. The livelihood and employment pattern of different communities is presented in section 3. This analysis is primarily concentrated on the sample of 29 households selected for close monitoring. It provides an idea of the extent of dependence of these communities on forests and other income sources, which have direct bearing on the biodiversity in the area. It helps to draw conclusions on the importance of fisheries in relation to other income sources of these groups. A scientific and technical discussion of the fishery activities including the catch composition, seasonality, breeding pattern, biology, and behaviour of fish stock etc., is made in the fourth section. The discussion is aimed to present the consequences of fishery activities in the lake more from the perspective of implications on the biodiversity conservation of the area coupled with those on the sustenance of dependent communities, than from the standpoint of examining the issue in a strict biological sense.

The institutional set-up to promote and deter resource exploitation in the area and the interrelations among the various institutions in the study area in the course of their activities to promote the fishery and conserve biodiversity is analysed in Section 5. In Section 6, the socio-economic condition of the two tribal groups and their perspectives on the relevant issues are analysed. The analysis throws light on the alternate opportunities available to the communities, their income pattern, and their occupational mobility.

Based on the analysis, the different options available before the managing authorities to reduce the conflicts are presented in the seventh section. The pros and cons of different alternatives are also discussed. The final Section presents the summary, draws conclusions, and indicates their policy implications.

## 2. Periyar Tiger Reserve: Biodiversity of the area and the methods of the study

### Periyar Tiger Reserve

Periyar Tiger Reserve (PTR) is located on the Western Ghats between 9° 15' and 9° 40' N Latitude and 76° 55' and 77° 25' E Longitude in the Idukki district. The Reserve is unique and renowned for its wide variety of large mammals. The formation of the reserve is closely associated with the construction of Mullaperiyar Dam across the river Periyar in 1895 for diverting water to Tamil Nadu State. As early as 1899, an area consisting of 600 sq. km surrounding the dam was declared Reserve Forests (Periyar Lake Reserve Forests) by the then *Maharajah* of Travancore. The intention of the declaration might have been to protect the catchment areas for prevention of silting of the dam.

The wildlife sanctuary was established in 1934. In 1950 the area was extended by 177 sq. km. Recognising the importance of the reserve it was brought in 1978 under Project Tiger and came to be known as the Periyar Tiger Reserve. For the purpose of management, the entire reserve is divided into three zones viz., Core area (350 sq. km), Buffer zone (377 sq. km) and Tourism zone (50 sq. km). The core area of the sanctuary was declared a National Park in 1982 (Fig. 2.1).

The two streams of Periyar and Mullayar and the lake with an area of 26 sq. km form the major aquatic ecosystem of the reserve. The Mullayar stream originating at an altitude of about 1780m above MSL has a length of 31 km and joins the southern tip of the lake. The Periyar stream having a length 41 km originates at an altitude of 1593m MSL (Map 2.2) and joins the lake at its eastern tip. The system is more or less a closed one due to the presence of the Mullaperiyar dam. Water from the reservoir overflows down stream when the water level reaches 41m though this happens very rarely (only twice for a couple of days in a decade). The only outlet of the reservoir is to the plains of Tamil Nadu through drainage pipes laid from the lake.

PTR has been known to be a mega biodiversity zone due to its rich and diverse ecosystems. About 5,000 of India's 15,000 species of flowering plants are found in this area. Of these 2100 species are endemic to Western Ghats. There are five distinct vegetation types identified within the sanctuary viz. evergreen, semi-evergreen, deciduous forests, grasslands, and eucalyptus plantations. Evergreen and semi-evergreen forests are found in the buffer and core zones and occupy about 40 percent of the total area of the reserve. Owing to heavy stocking and the presence of different layers, light penetration is low and hence ground vegetation not significant. The common tree species found in similar forest types are also present here such as *Cullenia excelsa*, *Dipterocarups bourdilloni*, *Vateria indica*, *Canarium strictum*, *Artocarpus hirsutum*, *Callophyllum tomentosum*, *Xylia xylocarpa*, and *Gluta travancorica* (Cooper, 1997).

The area surrounding the lake and the tourist zone has a mixture of semi-evergreen and moist deciduous forests interspersed with grassland both in the valley and the hilltops. A

Figure 2.1 Periyar Tiger Reserve, Kerala

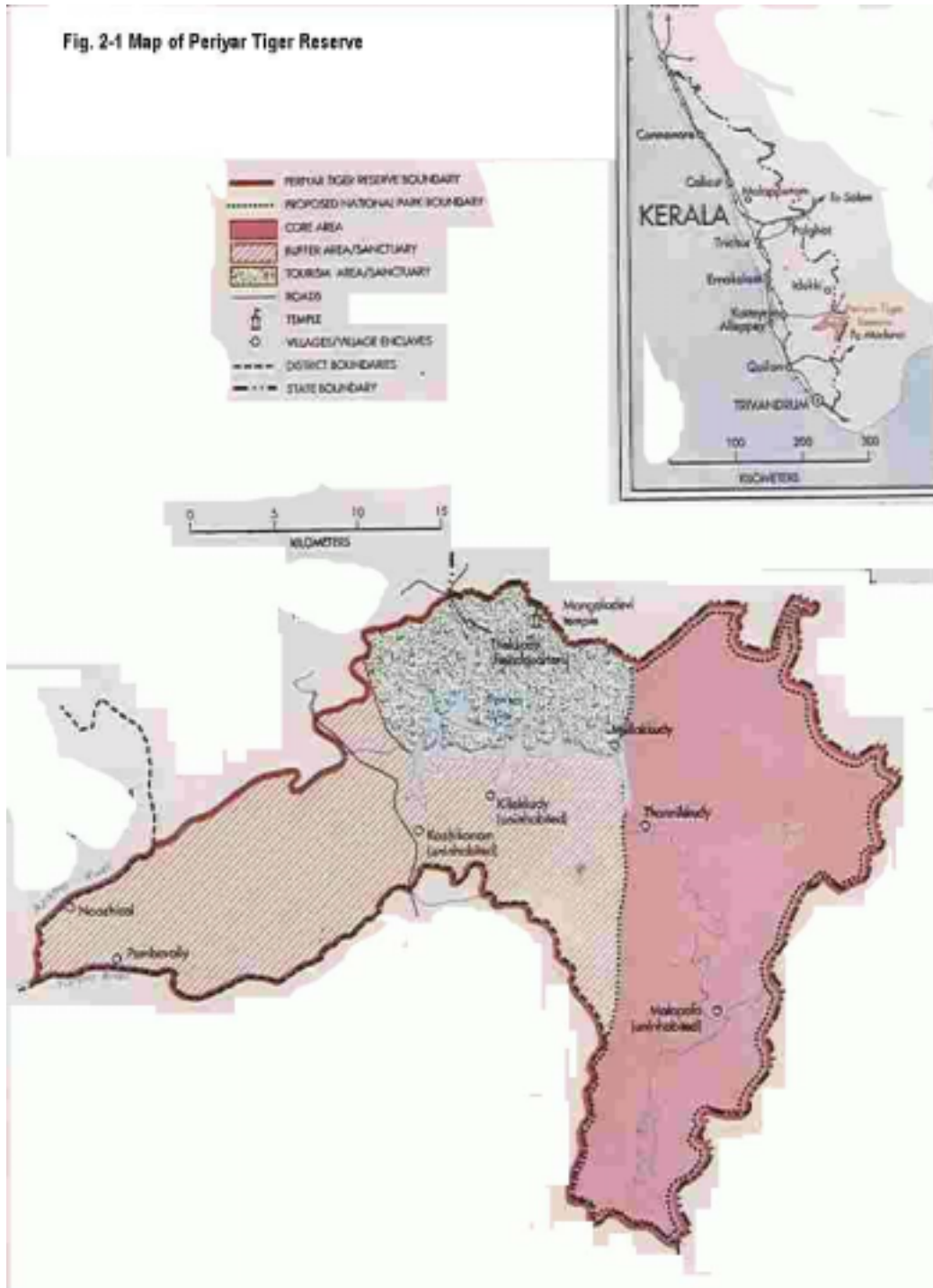
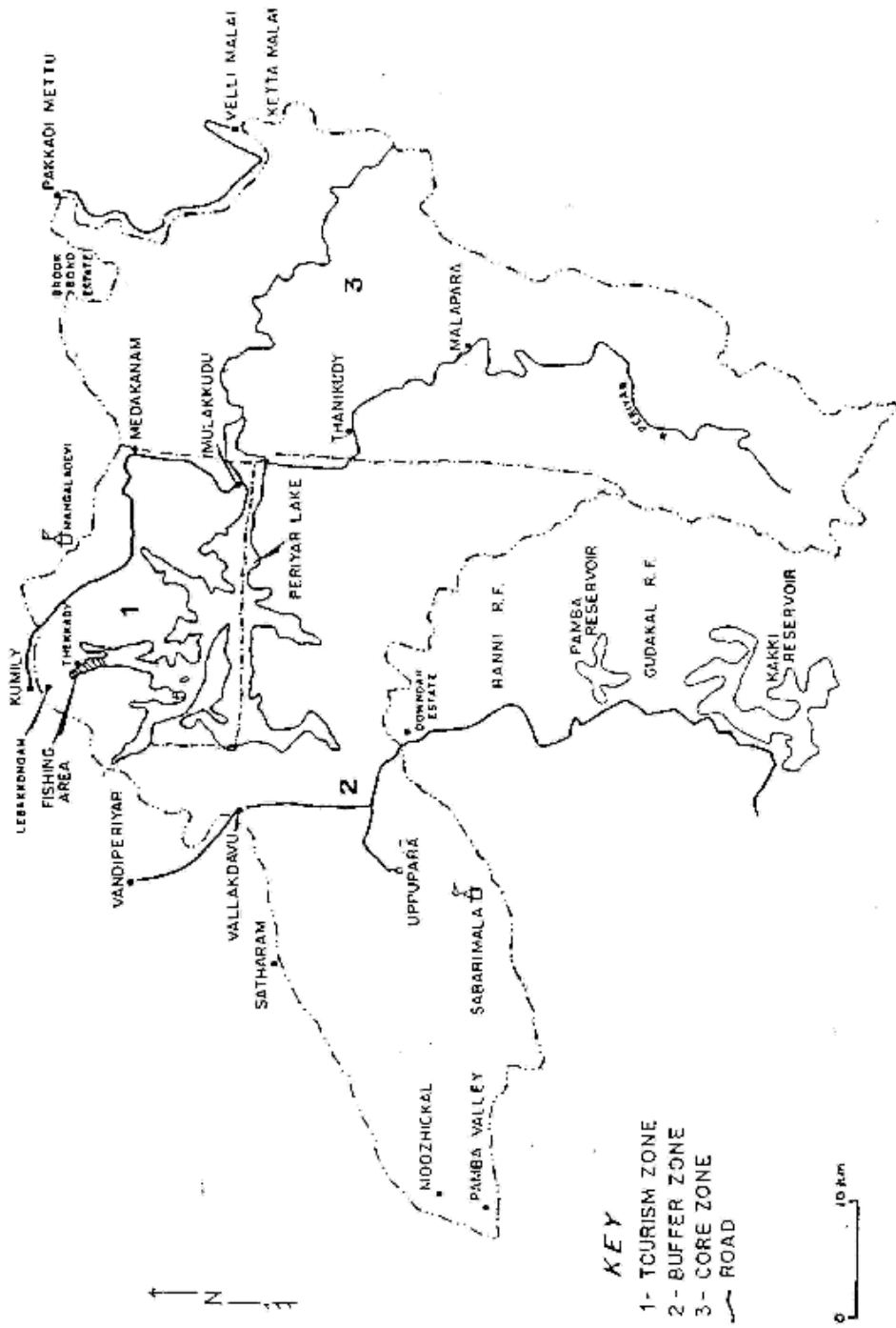




Figure 2.2 Periyar Tiger Reserve Management Zonation



large variety of common deciduous trees such as *Bombax malabaricum*, *Careya arborea*, *Pterocarpus marrsupium*, *Lagerstroemia lanceolata*, *Tectona grandis*, and many species of *Terminalia* and *Fiscus* are common in these forests (Asari, 1986). The grasslands, a distinctive feature of PTR, are found often scattered with clumps of dwarf Phoenix. Two types of grasslands are identified such as the South Indian subtropical hill Savannah grass lands (with trees like *Terminalia paniculata* and *Embllica officinalis*) and the southern montane wet grass lands (with grasses only). The main variety is elephant grass, commonly grazed by elephants, deer, and bison.

The rich flora of PTR also supports large number of mammals, birds, reptiles, amphibians, and fish. Nearly 120 species of lower vertebrates and amphibians are found, of which 85 are endemic. There are 49 mammals identified which include tiger, panther, wild dog, jungle cat, elephant, gaur, sambar, barking deer, mouse deer, nilgiri langur, bonnet macaque, lion-tailed macaque, bear, porcupine jackal, Indian giant squirrel, Malabar flying squirrel, wild boar, small Indian civet, common palm civet, mongoose, hare, pangolin, and Nilgiri thar.

### **Fishes in Periyar**

The first study on the fishes of Periyar reserve (Chacko, 1948) reported 35 species in the system. A recent study (Arun, 1997) showed that only 27 species exist in the Periyar aquatic ecosystem (lake and streams). Of these, 14 are endemic to Western Ghats and/or Periyar; 14 species have threatened<sup>2</sup> status and nine threatened and endangered status (Table 2.1). All loach species except Malabar loach (*Lepidocephalus thermalis*) are endemic to Western Ghats; one among them - Travancore *jonesi* – has the threatened status. Two snakeheads are also present in the system, but these are very rarely found in the catches. Of the 13 cyprinid species found in the system, eight are endemic to Western Ghats and three are exclusively endemic to Periyar Lake and streams (Table 2.1). All endemic cyprinids except *Gara mullya* are threatened.

The cat fishes (*Heteropneustes fossilis* and *Glyptothorax madraspatanam*) and spiny eel (*Mastacembelus armatus*) are also threatened. Two species such as Tilapia (*Oreochromis mossambicus*) and European Carp (*Cyprinus carpio communis*) are the exotics found in the system. That these species were absent in the study conducted in 1948 (Chacko, 1948), points out the fact that these were introduced in the system after 1948. The official records of the Forest Department lack details on the date of introduction. These species are also found in the down stream Idukki reservoir, where they were introduced in the mid-seventies by the Kerala Fisheries Department as part of Fisheries Development Programme in the reservoirs (Gopinathan and Jayakrishnan, 1984). It is physically impossible for the fishes to migrate to Periyar Lake because of the presence of Mullaperiyar Dam. These facts show that these two species were introduced deliberately by the Fisheries department or some fishery enthusiasts illegally into the system possibly in the 1970s. The introduction might have taken place without the permission of the Forest Department.

Eight new species not mentioned in the first study (Chacko, 1948) were recorded by Arun (1997). This means a total of 16 species are found to be missing now (Table 2.2). From the

**Table 2.1 Abundance Index of Fish Species in Different Locations of Periyar Lake-stream System**

	Fish Species	Common name	Local name	Status	Lake	Stream	Overall
1	<i>Aplocheilichthys lineatus</i>	Top minnow	Manathukanni		0.08(s)		0.04(s)
2	<i>Bhavana australis</i>	Western Ghat loach	Kainakki	EW		0.14 (s)	0.07 (s)
3	<i>Noemacheilichthys denisoni</i>	Denison's loach	Koitha	EW		0.63 (m)	0.31 (s)
4	<i>N. guentheri</i>	Guenther's loach	Koitha	EW		1.45 (a)	0.73 (m)
5	<i>N. keralensis</i>	Kerala loach	Koitha	EW		0.06 (s)	0.03 (s)
6	<i>Travancoria jonesi</i>	Travancore loach	Kalsravu	EW, TT (Rare & endemic - Kurup, 1994)	0.01 (s)	0.01 (s)	0.01 (s)
7	<i>Channa gachua</i>	Brown snakehead	Valton	TT (Endangered- Kurup, 1994)	0.02 (s)		0.01 (s)
8	<i>C. striatus</i>	Striped snakehead	Varal	TT (Endangered - Kurup, 1994)	0.01 (s)		0.01 (s)
9	<i>Oreochromis mossambicus</i>	Tilapia	Tilapia	XO	0.37 (s)		0.09 (s)
10	<i>Lepidocephalus thermalis</i>	Malabar loach	Manalaron			0.10 (s)	0.05 (s)
11	<i>Banius bakeri</i>	Malabar baril	Pavukan	EW, TT (Rare & endemic - Kurup, 1994)	0.15 (s)	1.40 (a)	0.78 (p)
12	<i>Crossocheilus periyarensis</i>	Periyar lalia	Karimpachi	EP, TT (Limited distribution ?)		0.28 (s)	0.14 (s)
13	<i>Cyprinus carpio communis</i>	European carp	Goldfish	XO	0.46 (m)		0.23 (s)
14	<i>Danio aequipinnatus</i>	Giant danio	Pavukan	EW, TT (Rare & endemic - Kurup, 1994)		1.36 (a)	0.68 (m)
15	<i>Garra mcClellandi</i>	Kauvery garra	Kallotti	EW	0.88 (p)	0.74 (m)	0.81 (p)
16	<i>G. mullya</i>	Common stone-sucker	Kallotti		1.46 (a)	1.16 (a)	1.31 (a)
17	<i>Lepidopygopsis typus</i>	Periyar trout	Brahmanakanda	EP, TT (Indeterminate*-Mahanta et al., 1994)	0.06 (s)	0.40 (m)	0.23 (s)
18	<i>Puntius curmuca</i>	Curmuca barb	Kooral	EW, TT (Endangered - Kurup, 1994)	0.68 (m)	0.84 (p)	0.76 (p)
19	<i>P. ophioccephalus</i>	Channa barb	Eetiakanda	EW, TT (Limited distribution ?)		0.25 (s)	0.13 (s)
20	<i>P. micropogon periyarensis</i>	Periyar barb	Kariyan	EP, TT (Limited distribution ?)	0.10 (s)	0.34 (s)	0.22 (s)
21	<i>P. melanampyx</i>	Tiger barb	Vazhakkavarayan	EW, TT (Endangered - Kurup, 1994)	0.49 (m)	0.21 (s)	0.35 (s)
22	<i>Rasbora daniconius</i>	Common rasbora	Kananjon		1.07 (p)	0.11 (s)	0.59 (m)
23	<i>Tor khudree</i>	Mahseer	Kuyil	TT (Indeterminate*- Mahanta et al., 1994)	0.52 (m)	0.93 (p)	0.72 (m)
24	<i>Mastacembelus armatus</i>	Spiny eel	Aaron	TT (Indeterminate*- Mahanta et al., 1994)	0.06 (s)	0.01 (s)	0.04 (s)
25	<i>Heteropneustes fossilis</i>	Stinging catfish	Kari		0.52 (m)		0.26 (s)
26	<i>Ompok bimaculatus</i>	Indian butter catfish	Chottuvala	TT (Vulnerable*-Mahanta et al., 1994)	0.03 (s)	0.03 (s)	0.03 (s)
27	<i>Glyptothorax madraspatanam</i>	Travancore sucker catfish	Kalsravu	EW, TT (Rare & endemic - Kurup, 1994)		0.02 (s)	0.01 (s)
	<b>Number of species</b>				<b>18</b>	<b>21</b>	<b>27</b>

Alphabets in parentheses indicate relative abundance. s=scarce; m=moderate; p=plenty and a = abundant (\*NBFGR categorization for threatened fishes). EW= endemic to Western Ghats; EP= exclusive endemic to Periyar lake and streams; TT= threatened; XO= exotic

point of view of biological diversity, disappearance of 16 species in the span of 50 years is alarming. The tribal inhabitants in Periyar exploit commercially two of the threatened species (*Tor khudree* and *Puntius curmuca*) together with the two exotic species, European carp (*Cyprinus carpio communis*) and Tilapia (*Oreochromis mossambicus*). Tribal woman fish some of the other threatened small species, which they dry, assort, and sell as *podimeen*.

**Table 2.2 Disappeared Fish Species of Periyar Lake-stream System**

Family	Scientific name	Common name
Anguillidae		
01.	<i>Anguilla bengalensis</i> Day	Indian longfin eel
02.Bagridae	<i>A. bicolor</i> McClelland	Shortfin eel
03.	<i>Macrones cavasius</i> Day	Gangetic mystus
04.Cyprinidae	<i>M. vittatus</i> Day	Striped dwaf catfish
05.	<i>Barilius bendelisis</i> (Hamilton - Buchanan)	Hamilton's baril
06.	<i>B. gatensis</i> (Valenciennes)	River-carp baril
07.	<i>Chela boopis</i> (Day)	Razorbelly minnow
08.	<i>Garra lamta</i> (Hamilton-Buchnan)	Lamta garra
09.	<i>Puntius amphibius</i> (Valenciennes)	Scarlet banded barb
10.	<i>P. arulius</i> (Jerdon)	Longfin barb
11.	<i>P. melanostigma</i> (Day)	Wynaad barb
12.Gobiidae	<i>P. pinaratus</i> Day	Olive barb
13.Mastacembelidae	<i>Glossogobius giuris</i> (Hamilton-Buchnan)	Tank goby
14.Notopteridae	<i>Rhyricobdella aculeata</i> (Bloch)	One-stripe spiny eel
15.Schilbeidae	<i>Notopeterus notopterus</i> (Pallas)	Grey featherback
16.	<i>Siludia sykesii</i> Day	White catfish

Source: Arun (1997)

### **Tribesfolk of PTR**

Four tribal groups, viz., *Mannans*, *Paliyans*, *Malaarayans*, and *Uralis*, inhabit PTR and surrounding areas. These groups, which once lived deep inside the forests, were relocated to the boundary of the buffer zone at the time of creation of the reserve. These communities live in three settlements around the reserve; *Mannan* and *Paliyan* settlements are located at Labakkandam near Kumili, and *Malaarayans* live in Moozhikkal part of the Reserve. *Uralis* are settled at the Vanchivayal settlement. The Labbakandam colony is located near the lake. Of these tribal groups, *Mannans* are the traditional tribal fishermen. Considering the importance of fishing in their livelihood, the Forest Department has given fishing rights to the community. *Paliyans* primarily depend on firewood collection and casual labour, though they also engage in fishing at times. Since only these two groups are engaged in the fishing activities, our interest in this study is limited to them.

### Box 2.1 Details of Tribal Settlements in and around PTR

Settlement	Tribal Groups	Area Occupied (ha.)	No. of families	Main Occupation
Labbak-kandam	<i>Mannans &amp;</i>	88	240	Fishing
	<i>Paliyans</i>	62	101	Firewood collection
Vanchivayal	<i>Uralis</i>	18	39	Agriculture
Moozhikkal	<i>Malaarayans</i>	112	189	Agriculture

#### Profile of tribal groups

##### *Mannans*

As noted earlier, the *Mannan* community is considered one of the traditional tribal fisherfolk. This community is found only in the Idukki district. It is said that *Mannans* were once the dependants of the chieftains in Madurai. The rivalry among the two groups of the community, viz., *Chakkans* and *Nayans* had led to the flight of the *Chakkan* group towards Idukki forests in Kerala. Later they settled in different parts of Idukki district. Earlier reports on these groups show that their economic conditions were better than those of other groups (Nagam Aiya, 1906). The groups in Thekkady were later relocated from the core zone of the Reserve to the periphery in Labbakkandam colony in the late 1930s. They now occupy nearly 88 ha of forestland. Each family was given land for cultivation and settlement. There are 240 families residing in the settlement. Though it is men who primarily do the fishing, women also participate in fishing. As a leisure-time activity, women engage themselves in the collection of small fishes using a unique vessel trap method. These are dried and sold in the market.

##### *Paliyans*

Another important tribal group in PTR is the *Paliyans*. They were also relocated in 1935 from the places such as Mangaladevi, Methkannam, Poovarasu, and Mullakudi to the northern boundary of the Reserve now known as Paliyakudi (*Paliya* settlement); this area also forms part of Labbakkandam. There are 101 families in this settlement who occupy about 62 ha of forestland. They were also given in addition, forestland for cultivation. The main occupation of these tribal folk is firewood collection; they work also as casual labour.

#### Method of the study

The main objective of the study as mentioned earlier is to understand the nature of conflicts and other issues associated with biodiversity conservation. The study focussed its attention primarily on the nature and pattern of fishery activities and their impact on fishery resources. Another objective is to understand the livelihood pattern of tribal dependants and the importance of fishery in it. Since these objectives call for both socio-economic and scientific and technical information, a multi-disciplinary approach is employed.

## Socio-economic and livelihood activities of tribal communities

A reconnaissance survey was conducted in the Labbakkandam settlement during March-April 1997 to gain a preliminary understanding of the activities in the area. The survey revealed that the main occupation of *Mannans* is fishing (40 percent) and agriculture (28 percent). A few depend on other occupations such as casual labour (8 percent). But firewood collection is the prime activity for *Paliyans* (49 percent). Twenty-two percent and 17 percent depend on casual labour and agriculture respectively (Box 2.2).

### Box 2.2 Details of Reconnaissance Survey on occupation

Primary Occupation	Mannans (%)	Paliyans (%)
Fishing	40	2
Firewood collection	5	49
Agriculture	28	17
Casual Labour	8	22
NTFP collection & others	19	10
Total	100	100

For the detailed study on the pattern of employment and nature of dependence, we decided to conduct two types of survey, one to trace the livelihood activities for a period of one year, and the other to understand their socio-economic status. For the former, based on the information from the reconnaissance survey, a sample of 29 households was selected purposively<sup>3</sup> from the two groups comprising 21 from *Mannans*<sup>4</sup> and eight from *Paliyans*. The criterion for the selection was the primary occupation of the households. Only the employment pattern of the head of household was given importance<sup>5</sup>. The primary occupation of selected households represented the general cross section of the employment opportunities available in the area. The selected *Mannan* households included those depended primarily on fisheries (seven households), collection of Non-Timber Forest Products (three), Agriculture (three), and others (eight) comprising employment as forest watcher, casual labourer, etc. The selected households of the *Paliyan* community included those engaged primarily in firewood collection (four), casual labour (two) cultivation (one), and other occupations (one). Primarily information on employment (nature of employment and number of days of work) was collected using data sheets. The data collection was entrusted to a local *Mannan* woman who knew the selected households intimately. The investigators conducted fortnightly check-up. The information collected from these households includes also details on type of job, time spent, products collected, and whether for self-use or sale. The purpose of this enquiry was to understand different aspects such as, occupational pattern, intensity of each activity, seasonality, income generation, occupational overlap, and possibility of substitution among different occupations.

A socio-economic survey was also conducted among 59 selected households (including all the 29 households selected for year-round monitoring) from the settlement to collect detailed information on the following: family details, size of land holdings, agricultural practices, income-expenditure patterns, forest produce collection – fish, NTFPs, firewood, fodder – collection methods and practices, attitude towards forests and wildlife conservation, and attitude towards institutional arrangements.

### *Scientific studies on fishery activities*

In order to understand the intensity and sustenance of fishery, information on landing details, breeding patterns, extent of extraction, behaviour of fish stock, and catch structure are needed. The two main fishing areas in the lake are the Anchuruli and Nellikkampetty. Those who fish at Anchuruli sell their catch at the Anchuruli road near the colony; those who fish at Nellikkampetty sell it at the Thekkady junction. Landing details from these two sites were collected periodically (twice a week) for a period of one year. A tribal youth was employed for this. Length and weight details of sample fishes were also collected together with this for understanding the structure and behaviour of fish stock. Ten sample fishes of commonly harvested species (*T.khudree*, *C.carpio communis*, *P.curmuca*, and *O.mossambicus*) were collected bimonthly from the landing to study their breeding patterns. Analyses were carried at the Department of Aquatic Biology and Fisheries, University of Kerala using the standard methods. Fecundity (number of eggs present) and Gonado Somatic Index<sup>6</sup> were estimated. Relation between length and weight and fecundity were arrived at to understand the behaviour of fish stock. Using GSI as base, information on maturity and spawning season was arrived at, as these items of information have significant implication for management policies. Studies on all the four commercially harvested fish species were conducted. In addition, information on the biology and ecology of fish species of Periyar lake was collected and compiled. The study conducted by Arun (1997) was used as baseline data on breeding patterns, feeding preferences, community composition, etc. Along with these, a survey of the type of fishing gears in use was also conducted.

### 3. Livelihood Pattern of Forest-dependent Communities in the Reserve

#### Employment opportunities in PTR

Prior to the establishment of the sanctuary, the main tribal groups in the area, viz. *Mannans* and *Paliyans*, had been completely dependant on forests for their livelihood. The establishment of the sanctuary restricted their rights on the forests, as they were relocated to the periphery. Considering the importance of forests on the livelihood of these people, the forest department granted them a number of concessions.

Of these, the most important was allowing fishing rights in the lake granted for the *Mannans*. The department also allowed collection of firewood from the buffer zone, near to the settlements. Tribesfolk, especially the *Paliyans*, collect firewood for sale. They are also allowed to collect non-timber forest produce such as honey and dammar. As part of the management and protection activities, the forest department employs firewatchers and protection watchers. The major proportion of these jobs is reserved for these tribal groups. Besides, forest land is allotted to the tribes for cultivation. The climate and the terrain are best suited for the cultivation of perennial cash crops such as cardamom, pepper, and cocoa. A few also raise rice, plantains, tapioca, etc. Thus the employment opportunities available to the two indigenous groups may be categorised as fishing, firewood collection, collection of non-timber forest produce, casual labour and cultivation. The primary investigations conducted during the initial stages of the study also revealed that there were marked differences in the employment pattern as between these two groups.

#### Employment pattern

The analysis of the employment data revealed that fishing and firewood collection are the major forms of employment in PTR, followed by cultivation and casual labour. There are also variations between the communities regarding employment pattern. Fishing is the major employment for *Mannans* while firewood collection is for *Paliyans*.

On an average, *Mannans* engage themselves in fishing for 13 days a month for 43 percent of their working time. Farming forms the next important job (5.1 days – 17 percent). They are unemployed<sup>7</sup> for nearly five days a month (16.5 percent). Just as fishing is for *Mannans*, firewood collection is for *Paliyans*; it nearly accounts for 40 percent of their time (12 days/month). Farming (6.2 days/month) and casual work (3.9 days/month) followed next in importance. Compared to *Mannans*, *Paliyans* are more unemployed [(16.5 percent compared to 17.4 percent); Table 3.1 and Fig. 3.1].

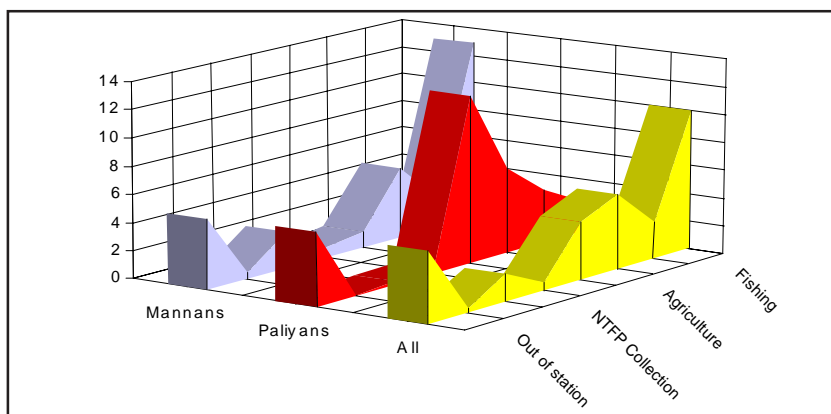
It is also seen that significant difference exists in the employment pattern as between *Mannans* and *Paliyans*. Variation is greater and more significant in firewood collection and fishing. There is also significant variation in the number of days of employment in casual labour and other jobs. Regarding farming and unemployment/leisure the communities exhibit similar characteristics (Fig. 3.1).



Table 3.1 Occupational Pattern of Tribesfolk (*Mannans and Paliyans*) in PTR (1997-'98)

Activities	Mean Days/month			Percentage to Total			Variance			F	Prob
	Maman	Paliyan	All	Maman	Paliyan	All	Maman	Paliyan	All		
	Fishing	130	24	100	42.9	7.8	33.2	6.251	4.740		
Casual Labour	22	39	2.6	7.2	12.8	8.8	1.168	5.123	2.286	3.461	0.042
Agriculture	5.1	6.2	5.4	16.8	20.4	17.8	10.664	4.549	5.340	0.498	3.259
Firewood collection	1.2	12.0	4.2	3.9	39.7	13.8	0.362	2.868	0.807	270.896	0.000
NIFP Collection	0.7	0.4	0.6	2.3	1.2	2.0	1.386	0.000	0.347	6.133	0.005
Others	2.6	0.2	2.0	8.8	0.8	6.5	0.573	0.000	0.143	4.975	0.012
Out of station	0.5	0.0	0.3	1.6	0.0	1.1	0.568	0.209	0.297	13.646	0.000
Unemployed	5.0	5.3	5.1	16.6	17.4	16.8	2.072	3.051	0.988	0.459	0.636
Total	30	30	30	100.0	100.0	100.0					

**Figure 3.1 Employment Pattern of Tribesfolk in PTR**



Taking the two communities together, we find that, on an average, fishing accounts for 10 days per month. The other important occupations are farming (5.4 days/month), firewood collection (4.2 days/month), and casual labour (2.6 days/month). The number of days of unemployment comes to 5.1 per month (Table 3.2).

**Table 3.2 Monthly Employment Pattern of Tribesfolk (*Mannans and Paliyans*) in Periyar Tiger Reserve (1997-'98)**

Month	Fishing	Casual Labour	Agriculture	Firewood collection	NTFP Collection	Others	Out of station	Unemployed
April	8.8	5.2	2.4	3.4	1.6	1.0	0.9	6.6
May	11.8	4.5	3.2	4.5	1.0	1.1	0.0	5.0
June	12.7	3.8	3.4	4.2	1.0	1.2	0.0	3.7
July	12.2	2.9	3.0	4.8	1.2	1.1	0.0	4.8
August	12.3	2.7	2.9	5.2	1.1	1.0	0.1	5.7
September	11.8	2.0	4.6	3.8	0.8	0.9	0.1	6.0
October	9.2	1.5	7.5	3.8	0.0	1.5	0.7	6.8
November	11.4	1.9	4.3	4.1	0.0	3.7	0.0	4.4
December	8.6	2.3	9.8	5.0	0.0	2.1	0.0	3.2
January	7.8	2.4	10.4	3.8	0.0	2.1	0.1	4.5
February	5.8	1.3	7.4	3.4	0.2	3.4	1.1	5.4
March	8.1	1.2	5.7	4.1	0.3	4.6	1.0	4.9
Total	120.4	31.8	64.5	50.1	7.3	23.8	4.1	60.9
Mean	10.0	2.6	5.4	4.2	0.6	2.0	0.3	5.1
SD	2.3	1.3	2.8	0.6	0.6	1.2	0.4	1.1

### Seasonal differences in employment pattern

Employment varies by season. In order to understand the pattern of the variation, month-

wise employment for two communities was analysed. The *Mannans* are found, in general, to be predominantly concentrated in fishing activities. About one-half of their monthly working time is spent on fishing. The peak months of employment are from late May to September and November (Table 3.3). The average duration of a fishing trip is 3.23 days with a maximum of 16 days and a minimum of one day. The duration of fishing trips is short in the rainy seasons, as the catch is high. They also limit fishing during rainy season to the lake only. During summer seasons they stay more days in the forests, going deep into their interior. They fish both in the lake and the streams during this season.

**Table 3.3 Monthly Employment Pattern of *Mannans* in PTR (1997-'98)**

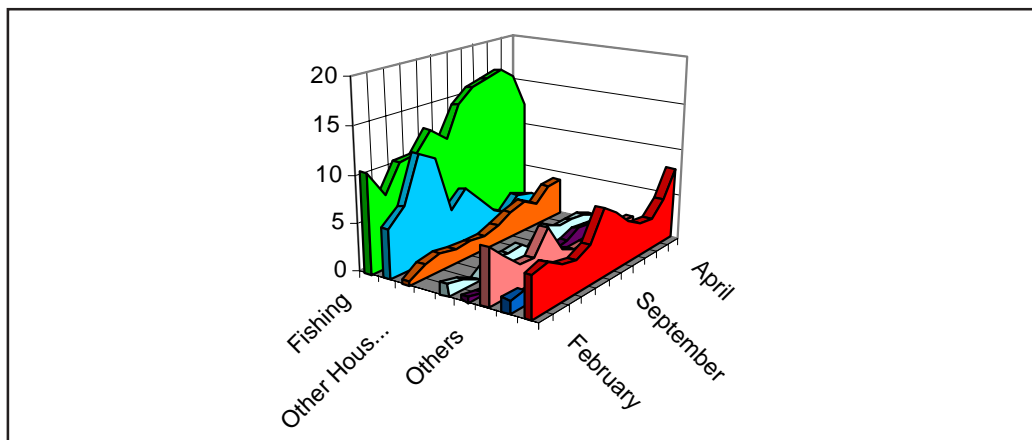
(No. of Days)

Month	Fishing	Casual Labour	Agriculture	Firewood collection	NTFP Collection	Others	Out of station	Unemployed
April	12.1	4.0	1.3	0.7	1.4	1.4	1.2	7.8
May	15.9	3.8	2.4	1.3	1.1	1.5	0.0	5.0
June	17.0	2.5	2.9	1.4	1.4	1.3	0.0	3.5
July	16.5	3.2	1.6	1.4	1.7	1.3	0.0	3.8
August	15.9	2.7	2.6	2.3	1.1	1.4	0.2	4.8
September	14.5	2.0	4.4	0.4	0.9	1.3	0.1	6.4
October	11.3	1.4	6.2	1.6	0.0	2.1	1.0	7.5
November	12.8	1.6	4.6	1.3	0.0	5.1	0.0	4.5
December	10.8	1.4	10.7	1.7	0.0	2.8	0.0	3.6
January	10.5	1.8	11.9	0.0	0.0	2.9	0.1	3.9
February	7.7	1.3	7.0	0.9	0.2	4.5	1.5	5.0
March	10.7	0.4	5.2	1.2	0.5	6.1	1.4	4.4
Total	155.5	26.1	60.8	14.2	8.4	31.8	5.7	60.1
Mean	13.0	2.2	5.1	1.2	0.7	2.6	0.5	5.0
SD	2.9	1.1	3.4	0.6	0.6	1.7	0.6	1.5

The *Mannans* commonly use different types of nets for fishing. The use of hook and line is not rare. The fishing season slowly vanishes after November. This marks the beginning of the pepper season. During this period, they devote more time to agricultural activities such as plucking pepper and also to cultural operations. This season lasts for two to three months i.e., from December to February. In this season time devoted for agricultural activities increases to nearly one-third of the month. Only very few are found to engage in the collection of non-timber forest products [(maximum of 0.6 days/month); Table 3.1]. Casual labour is not common among these communities. Most of the households collect firewood for self-consumption and only a few are engaged in selling firewood. The *Mannans* are, in general, unemployed for about five days in a month. The unemployed days include leisure time too (End Note 6). They are high in April (7.8 days) and October (7.5 days) and low during June and December. This is mainly due to the fact that June and December constitute the peak season in fishing and agriculture. The correlation between unemployment and fishing is

found to be negative (-0.17). It is also negative in the case of agriculture (-0.30), firewood collection (-0.20), and other jobs (-0.30) [Fig. 3.2 and Table 3.4).

**Figure 3.2 Employment Pattern of Mannans in PTR**



**Table 3.4 Monthly Employment Pattern of Paliyans in PTR (1997-'98)**

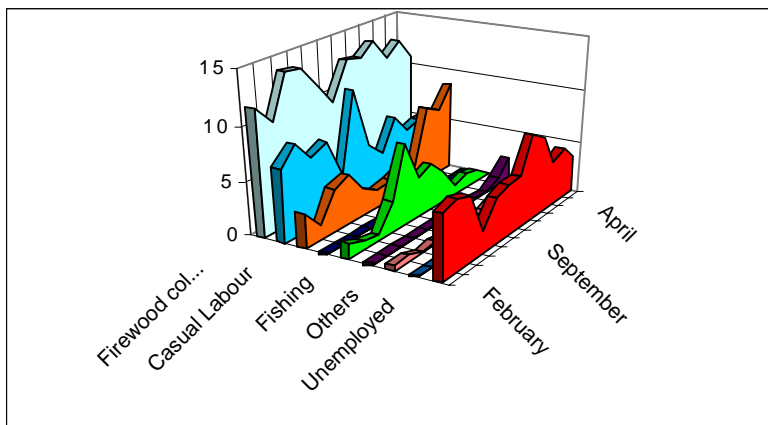
Month	Fishing	Casual Labour	Agriculture	Firewood collection	NTFP Collection	Others	Out of station	unemployed
April	0.0	8.5	5.3	10.8	2.0	0.0	0.0	3.5
May	1.0	6.5	5.3	12.8	0.6	0.0	0.0	4.9
June	1.5	7.3	4.8	11.6	0.0	0.8	0.0	4.1
July	0.9	2.1	6.5	13.6	0.0	0.6	0.0	7.3
August	3.0	2.6	3.6	12.6	1.0	0.0	0.0	8.1
September	4.5	2.0	5.0	12.9	0.6	0.0	0.0	5.0
October	3.8	1.8	11.0	9.5	0.0	0.0	0.0	4.9
November	7.6	2.6	3.5	11.4	0.0	0.0	0.0	4.4
December	3.0	4.6	7.4	13.6	0.0	0.3	0.0	2.1
January	0.6	4.0	6.5	13.9	0.0	0.0	0.0	6.1
February	0.9	1.4	8.5	10.0	0.0	0.6	0.0	6.6
March	1.5	3.3	6.9	11.8	0.0	0.5	0.0	6.1
Total	28.3	46.6	74.1	144.4	4.3	2.8	0.0	63.1
Mean	2.4	3.9	6.2	12.0	0.4	0.2	0.0	5.3
SD	2.2	2.4	2.1	1.4	0.6	0.3	0.0	1.7

For *Paliyans* fishing is only a minor occupation (2.4 days/month), whereas firewood collection, farming, and casual labour are more prominent [(12.0, 6.2, and 3.9 days /month respectively); Table 3.4]. The peak months for agricultural activities in their case are October and December to March (with minor variations) with the peak in October. *Paliyans* concentrate

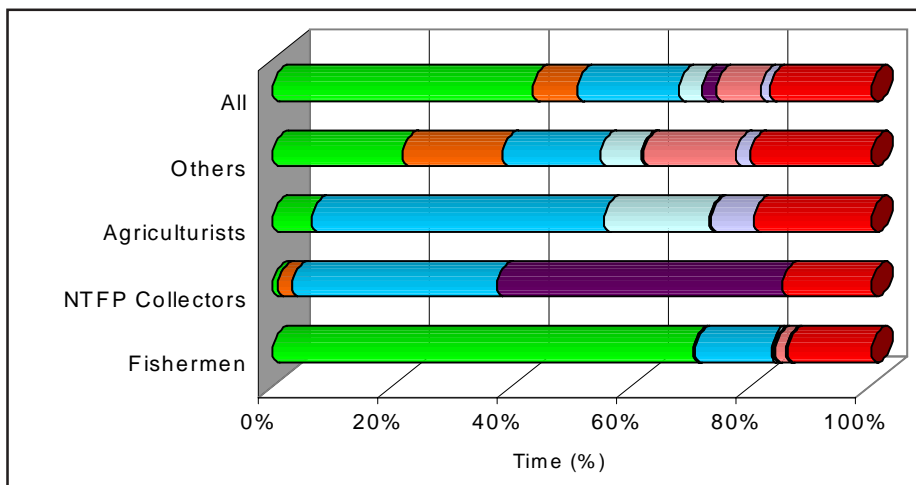
more on agricultural activities and raise a large variety of crops than *Mannans*. The crops include coffee, pepper, cardamom, plantains, tapioca, and rice. The number of days engaged for firewood collection is almost uniform with only minor variations (SD 0.6). The duration per firewood collection trip is one day. They start at 9.00 hrs and return at 15.00-16.00 hrs. The average distance of travel is 9.0 to 10.0 km (to and fro) per day of firewood collection.

Unlike *Mannans*, *Paliyans* use only hook and line for fishing. The number of days engaged for agricultural activities, other jobs and unemployment decline with increase in the number of days engaged for fishing (correlation coefficient  $-0.68, -0.30, -0.77$ ). Positive correlation is observed between fishing and NTFP collection. This is because during stay in the forests for fishing, they also collect NTFPs. The duration of fishing trips of *Paliyans* ranges from one to seven days with a mean of 1.75 days. This is much shorter than that of *Mannans* [(3.23 days); Fig. 3.3 and 3.4].

**Figure 3.3 Employment Pattern of *Paliyans* in PTR**



**Figure 3.4 Annual Employment Pattern of *Mannans* in PTR**



### Differences among different occupational categories

Based on the primary occupation, the selected households (*Mannans* and *Paliyans* together) may be grouped into six categories – Fishermen, Casual labourers, Agriculturists, Firewood collectors, NTFP collectors, and others. However, complete dependence on one occupation is absent. More or less, higher levels of dependence on a single occupation are seen in the case of fishermen and firewood collectors. Even for these groups agricultural work constitutes a complementary occupation.

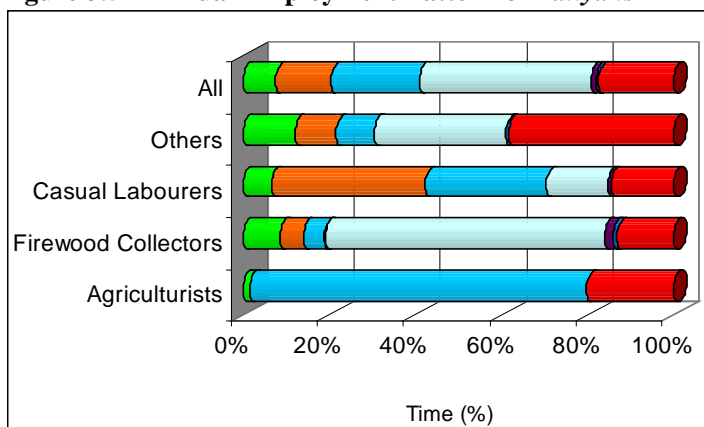
Fishermen: The fishermen are engaged in active work on an average for two-thirds of a month (i.e., 255.4 days/ year). Monthly variations are also high for this occupation (SD 4.0). During the peak season, the number of days of employment per month comes to 25. The lean period in fishing is the month of February. Agriculture provides 44.6 days of work pr year. Time spent on other occupations is negligible [(0.7 to 7 days a year); Table 3.5 and Fig. 3.5].

**Table 3.5 Monthly Employment Pattern of Fishermen in PTR (1997-'98)**

Month	Fishing	Casual Labour	Agriculture	Firewood collection	NTFP Collection	Others	Out of station	Unemployed
April	20.6	0.0	1.3	0.0	0.0	0.0	0.0	3.1
May	24.8	0.0	1.6	0.0	0.0	0.0	0.0	4.5
June	25.6	0.0	1.3	0.0	0.0	0.0	0.0	3.1
July	26.5	0.0	1.4	0.4	0.5	2.9	0.0	2.3
August	25.0	0.2	0.9	0.5	0.0	0.0	0.2	4.2
September	22.8	0.6	1.7	0.0	0.0	0.0	0.0	4.9
October	20.4	0.0	3.6	0.5	0.0	0.0	0.6	5.8
November	22.7	0.0	3.5	0.0	0.0	0.0	0.1	3.7
December	17.3	0.0	8.5	0.2	0.1	0.0	0.1	4.6
January	19.4	0.0	7.8	0.0	0.0	0.0	0.2	3.5
February	13.6	0.4	7.4	0.1	0.0	0.0	0.0	4.3
March	16.7	0.0	5.6	0.0	0.1	0.0	0.0	3.4
Total	255.4	1.2	44.6	1.7	0.7	2.9	1.2	47.4
Mean	21.3	0.1	3.7	0.1	0.1	0.2	0.1	4.0
SD	4.0	0.2	2.9	0.2	0.1	0.8	0.2	1.0

Agriculturists: Those who are primarily dependant on agriculture spend about 239 days per year for farming. During the peak pepper season, they work almost on all days. Next to agriculture, comes firewood collection (3.2 days/month). Firewood is collected mostly for own consumption. Some of them go for fishing also during August to November. Unemployment/leisure time is longer for this group (5.9 days/month) than for fishermen who engage in other occupations only in a limited way [(less than two days/month); Table 3.6 and Fig. 3.6].

**Figure 3.5 Annual Employment Pattern of *Paliyans* in PTR**

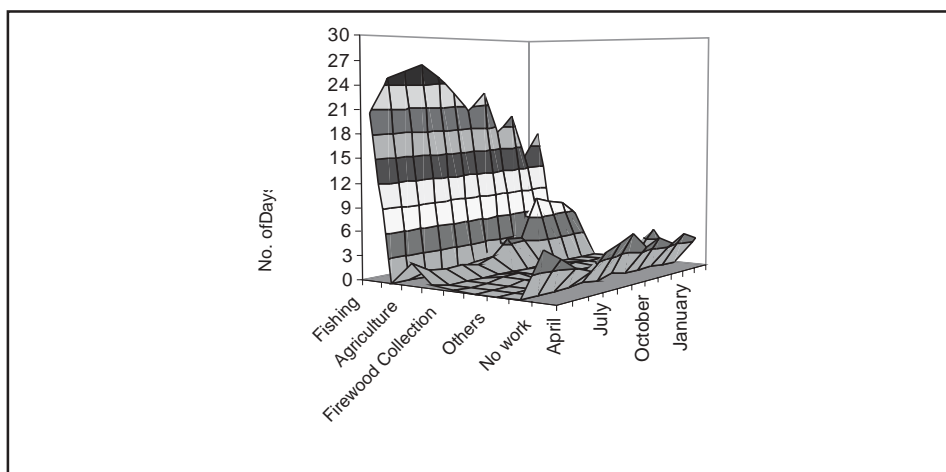


**Table 3.6 Monthly Employment Pattern of Agriculturists in PTR (1997-'98)**

Month	Fishing	Casual Labour	Agriculture	Firewood collection	NTFP Collection	Others	Out of station	Unemployed
April	0.0	0.0	23.0	6.0	0.0	0.0	0.0	1.0
May	3.0	0.0	17.5	3.5	0.0	0.0	0.0	7.0
June	0.0	0.0	23.0	6.0	0.0	0.0	0.0	1.0
July	0.0	0.0	20.5	5.0	0.0	0.0	0.0	5.5
August	2.5	0.0	18.5	2.5	0.0	0.0	0.0	7.5
September	3.0	0.0	16.0	0.0	0.0	0.0	0.0	11.0
October	3.0	0.0	20.5	3.0	0.0	0.0	0.0	4.5
November	2.5	0.0	15.0	3.0	0.0	0.0	0.0	9.5
December	0.0	0.0	30.0	0.0	0.0	0.0	0.0	1.0
January	0.0	0.0	18.5	0.0	0.0	0.0	0.0	12.5
February	0.0	0.0	16.0	4.5	0.0	1.0	0.0	6.5
March	1.0	0.0	20.5	4.5	0.0	0.0	0.0	4.0
Total	15.0	0.0	239.0	38.0	0.0	1.0	0.0	71.0
Mean	1.3	0.0	19.9	3.2	0.0	0.1	0.0	5.9
SD	1.4	0.0	4.1	2.2	0.0	0.3	0.0	3.9

Firewood collectors: The firewood collectors, mostly are *Paliyans* (Fig. 3.5), work for nearly 20 days a month (Table 3.7). The number of days of work range from a low of 15.5 days /month in the rainy season (June) to a maximum of 26.5 days in January. Between April and June, the number of days of firewood collection is low (Fig. 3.8). They go for fishing for about 32 days a year. It is the maximum in December (5.3 days). About for 3.7 days a month (44.3 days/year) they remain unemployed. Time spent on other occupations is very limited (Fig. 3.7).

**Figure 3.6 Employment Pattern of Fishermen in PTR**



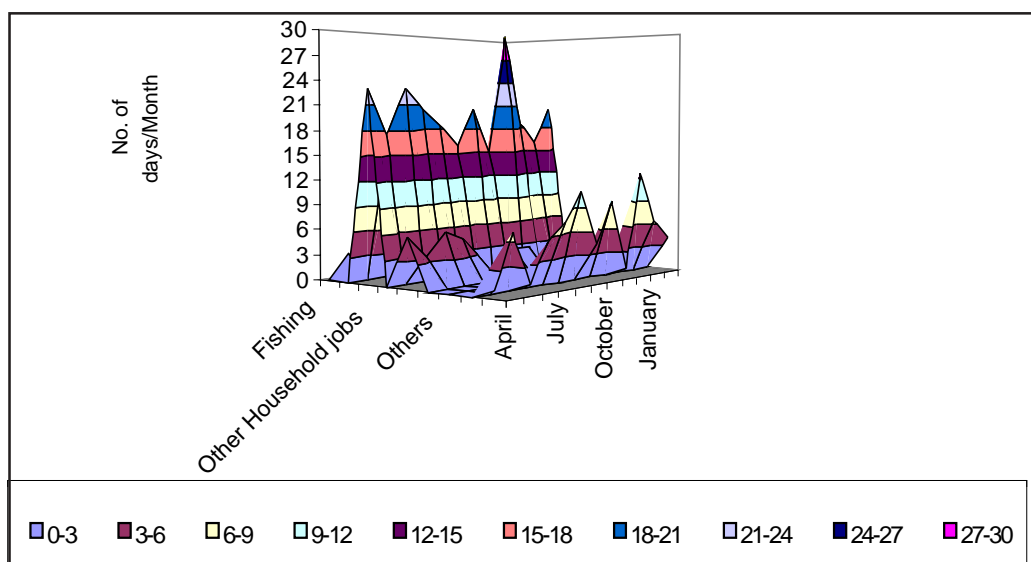
**Table 3.7 Monthly Employment Pattern of Firewood Collectors in in PTR (1997-'98)**

Month	Fishing	Casual Labour	Agriculture	Firewood collection	NTFP Collection	Others	Out of station	Unemployed
April	0.0	0.0	0.0	0.0	30.0	0.0	0.0	0.0
May	0.0	2.0	0.0	0.0	24.0	0.0	0.0	5.0
June	0.0	0.0	0.0	0.0	30.0	2.9	0.0	0.0
July	0.0	0.0	0.0	0.0	30.0	0.0	0.0	1.0
August	3.0	0.0	3.0	0.0	18.0	0.0	0.0	7.0
September	0.0	0.0	10.0	0.0	19.0	0.0	0.0	1.0
October	0.0	0.0	20.0	0.0	0.0	0.0	0.0	11.0
November	0.0	0.0	0.0	0.0	0.0	28.0	0.0	2.0
December	0.0	6.0	19.0	0.0	0.0	0.0	0.0	6.0
January	0.0	0.0	28.0	0.0	0.0	0.0	0.0	3.0
February	0.0	0.0	19.0	0.0	0.0	0.0	0.0	9.0
March	0.0	0.0	16.0	0.0	9.0	0.0	0.0	5.0
Total	3.0	8.0	115.0	0.0	160.0	30.9	0.0	50.0
Mean	0.3	0.7	9.6	0.0	13.3	2.6	0.0	4.2
SD	0.9	1.8	10.3	0.0	13.2	8.1	0.0	3.6

NTFP collectors: The duration of the collection trips varies widely from one day to more than one month per trip with a mean of 16.5 days. The number of trips ranges from 1 to 10 with a mean of 5.2 trips per month. The number of trips and the days spent per trip vary with the product collected and the season. The honey collection trips are generally short (lasting 1-5 days) compared to *cheevakkai* or *kunthirikkam* (dammar) collection trips. They



**Figure 3.7 Employment Pattern of Agriculturists in PTR**

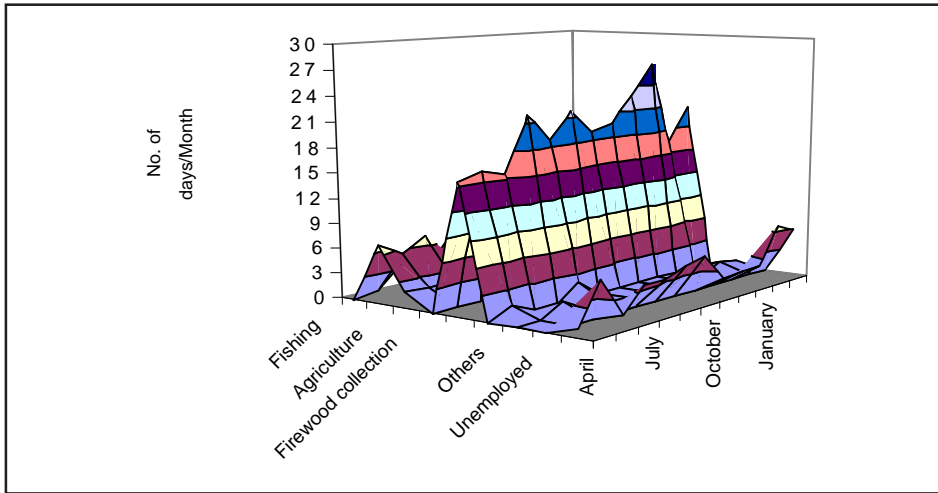


spend about 160 days a year for NTFP collection. After the NTFP season, they turn to agricultural activities (Table 3.8). They remain unemployed for about 4.2 days per month (Fig. 3.8). As in the case of fishermen and firewood collectors, they also spend little time on other occupations.

**Table 3.8 Monthly Employment Pattern of NTFP collectors in PTR (1997-'98)**

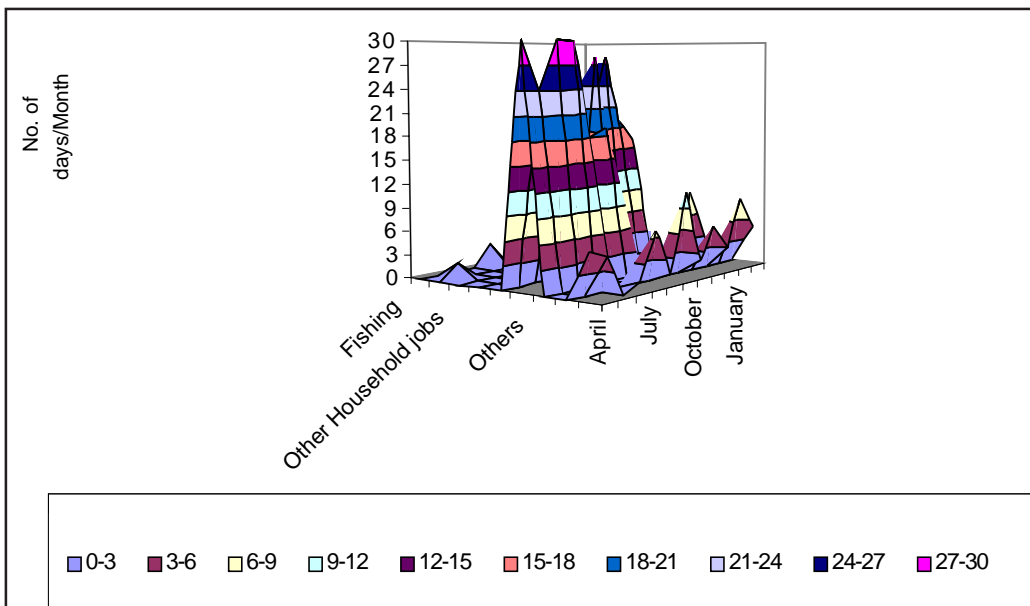
Month	Fishing	Casual Labour	Agriculture	Firewood collection	NTFP Collection	Others	Out of station	Unemployed
April	0.0	0.0	0.0	0.0	30.0	0.0	0.0	0.0
May	0.0	2.0	0.0	0.0	24.0	0.0	0.0	5.0
June	0.0	0.0	0.0	0.0	30.0	2.9	0.0	0.0
July	0.0	0.0	0.0	0.0	30.0	0.0	0.0	1.0
August	3.0	0.0	3.0	0.0	18.0	0.0	0.0	7.0
September	0.0	0.0	10.0	0.0	19.0	0.0	0.0	1.0
October	0.0	0.0	20.0	0.0	0.0	0.0	0.0	11.0
November	0.0	0.0	0.0	0.0	0.0	28.0	0.0	2.0
December	0.0	6.0	19.0	0.0	0.0	0.0	0.0	6.0
January	0.0	0.0	28.0	0.0	0.0	0.0	0.0	3.0
February	0.0	0.0	19.0	0.0	0.0	0.0	0.0	9.0
March	0.0	0.0	16.0	0.0	9.0	0.0	0.0	5.0
Total	3.0	8.0	115.0	0.0	160.0	30.9	0.0	50.0
Mean	0.3	0.7	9.6	0.0	13.3	2.6	0.0	4.2
SD	0.9	1.8	10.3	0.0	13.2	8.1	0.0	3.6

**Figure 3.8 Employment Pattern of Firewood Collectors in PTR**



Casual Labourers: This group comprises mostly the *Paliyan* community. They are employed as agricultural labourers in outsiders' farms. A few go for other works such as construction, and road maintenance. The period of their maximum employment coincides with the pepper season i.e. December-January. The average number of days of employment is 10.1 per month. They go for firewood collection when other jobs are not available. The land-possessing households work in their farms nearly 8.4 days per month. Here also the peak season coincides with the pepper season. Own farming forms the second largest source of employment for these communities. Occasionally they go for fishing also (Fig. 3.9 and Table 3.9).

**Figure 3.9 Employment Pattern of NTFP Collectors in PTR**

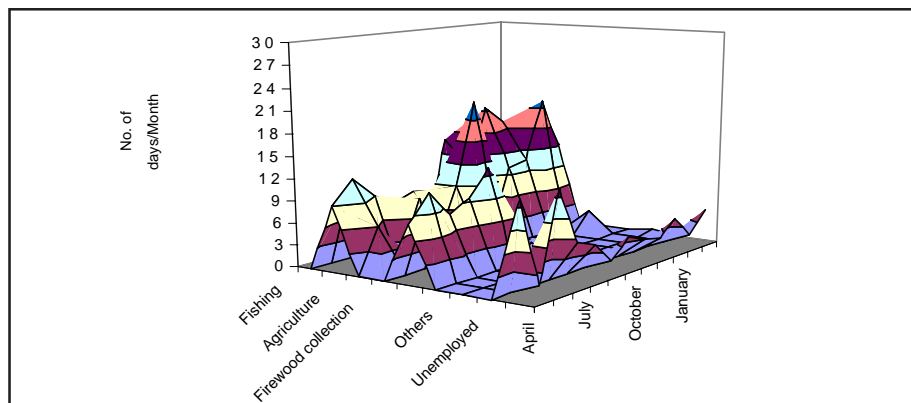


**Table 3.9 Monthly Employment Pattern of Casual Labourers in PTR (1997-'98)**

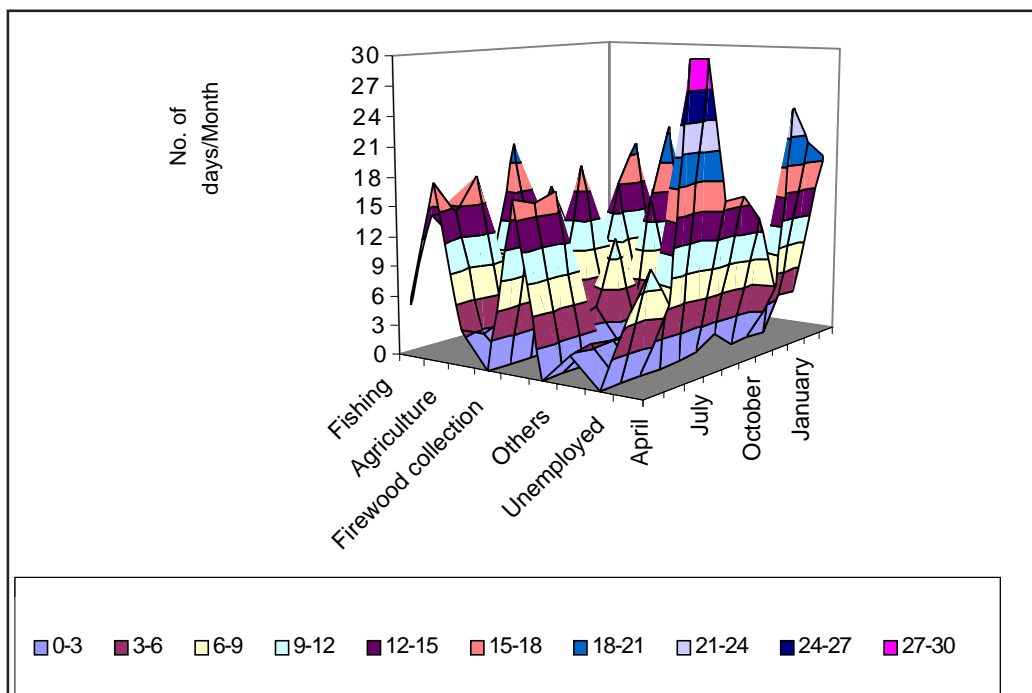
Month	Fishing	Casual Labour	Agriculture	Firewood collection	NTFP Collection	Others	Out of station	Unemployed
April	0.0	9.0	0.0	8.0	0.0	0.0	0.0	13.0
May	0.0	12.0	6.0	11.5	0.0	0.0	0.0	1.5
June	0.0	9.0	0.0	8.0	0.0	0.0	0.0	13.0
July	0.0	7.5	8.5	9.5	0.0	0.0	0.0	5.5
August	2.5	8.5	2.5	13.0	0.0	0.0	0.0	4.5
September	6.0	8.0	9.0	3.0	2.5	0.0	0.0	1.5
October	2.0	4.5	20.5	0.0	0.0	0.0	0.0	4.0
November	14.0	10.5	2.5	0.0	0.0	0.0	0.0	3.0
December	0.0	18.5	10.0	0.0	0.0	1.1	0.0	2.5
January	0.0	16.0	10.5	0.0	0.0	0.9	0.0	4.5
February	0.0	4.5	19.0	3.0	0.0	0.0	0.0	1.5
March	0.0	13.0	12.0	0.0	0.0	0.0	0.0	4.5
Total	24.5	121.0	100.5	56.0	2.5	2.0	0.0	59.0
Mean	2.0	10.1	8.4	4.7	0.2	0.2	0.0	4.9
SD	4.2	4.2	6.7	5.0	0.7	0.4	0.0	4.0

Other households: Those who do not have any one activity as their primary employment fall in this category. They practically go for all types of activities depending on availability. Of the available jobs, firewood collection forms the major employment source which provides about 68 days of employment a year. Fishing follows next with 60 days. Own farming and casual labourer provide, on an average, 4 to 6 days of employment per month. These people also go for work under the forest department such as protection watchers and firewatchers. These items of work are available only for few months i.e., on an average nearly 56 days in a year (Table 3.10 and Fig.3.11). They remain unemployed for nearly eight days per month.

**Figure 3.10 Employment Pattern of Casual Labours in PTR**



**Figure 3.11 Employment Pattern of Other Tribul Households in PTR**



**Table 3.10 Monthly Employment Pattern of Others in PTR (1997-'98)**

Month	Fishing	Casual Labour	Agriculture	Firewood collection	NTFP Collection	Others	Out of station	Unemployed
April	2.7	10.7	0.0	8.2	0.0	1.4	0.0	7.1
May	6.9	7.3	1.3	8.2	0.0	1.7	0.0	5.7
June	5.6	8.9	1.8	8.5	0.0	1.6	0.0	3.7
July	4.5	4.8	0.7	1.9	0.0	1.6	0.0	15.8
August	4.2	4.1	1.3	2.2	0.3	1.7	0.1	17.2
September	9.9	2.0	2.9	5.4	0.0	1.5	0.2	8.0
October	5.0	4.1	8.9	1.2	0.0	2.4	0.8	8.1
November	7.3	1.8	2.4	7.2	0.0	3.6	0.0	6.7
December	4.4	1.3	7.6	10.8	0.0	4.1	0.0	2.7
January	1.4	2.1	9.6	2.5	0.0	3.3	0.0	12.1
February	2.4	1.3	3.3	4.9	0.3	3.4	1.7	10.2
March	5.6	0.5	1.3	6.9	0.0	3.9	1.7	9.3
Total	60.0	48.9	41.1	68.0	0.6	30.1	4.5	106.4
Mean	5.0	4.1	3.4	5.7	0.0	2.5	0.4	8.9
SD	2.3	3.3	3.3	3.1	0.1	1.1	0.7	4.4

## Gender differences in occupational pattern

As expected, differences are observed as between men and women in their occupational patterns. Men spend time on fishing (11.7 days/month), agriculture (5.5 days/month), and firewood collection (3.4 days/month), in that order. The monthly variation in the employment pattern is not much though it is more for agriculture, fishing, and casual labour (SD 2.8, 2.4, and 1.2 respectively). On an average they are unemployed (or leisure) for 4.8 days/month (Table 3.11). The variation between months is very low in this regard (SD 0.9). The unemployed days are high in August, but the number of days of fishing is high in this month. Days spent for NTFP collection are very low (only 9.0 days per year) and are found mostly during April-September. Firewood collection days are low in the peak agriculture month of December and during the peak fishing season in June.

**Table 3.11 Monthly Employment Pattern of Males in PTR (1997-'98)**

Month	Fishing	Casual Labour	Agriculture	Firewood collection	NTFP Collection	Others	Out of station	Unemployed
April	10.3	4.1	3.0	3.5	2.0	1.3	0.0	5.8
May	13.1	4.0	3.4	3.7	1.3	1.3	0.0	4.2
June	14.6	2.6	3.6	2.8	1.3	1.5	0.0	3.7
July	14.1	0.7	2.9	3.8	1.5	1.4	0.0	5.2
August	14.5	1.4	2.2	3.8	1.3	1.3	0.2	6.3
September	12.7	1.2	4.7	3.7	1.0	1.2	0.1	5.3
October	11.0	0.6	8.4	2.9	0.0	1.9	0.3	5.9
November	13.8	1.0	4.1	3.3	0.0	3.4	0.0	4.4
December	9.7	1.9	9.6	3.8	0.0	2.6	0.0	3.4
January	9.7	1.4	9.8	3.7	0.0	2.4	0.1	4.0
February	7.3	0.7	8.1	3.2	0.0	3.2	0.8	4.8
March	10.0	1.1	5.9	3.3	0.4	4.4	0.0	4.9
Total	140.7	20.7	65.7	41.3	9.0	25.9	1.5	57.9
Mean	11.7	1.7	5.5	3.4	0.7	2.2	0.1	4.8
SD	2.4	1.2	2.8	0.4	0.7	1.0	0.2	0.9

In the case of women, time spent on firewood collection (83.8 days/year), casual labour (74.3 days/year), and agriculture (60.0 days/year) is higher. As casual labour, they work mostly in the nearby private cardamom estates. Only a few go for fishing. Women accompany men in fishing. They practise a unique method of fishing of small fishes with vessel traps. The fish they catch is sold in dried form. The number of days engaged for agricultural activities are more during the pepper season (December -January). Compared to males, the number of days of unemployment is high for females<sup>8</sup> [72.5 days/month, (Table 3.12)] compared to 57.9 days for males.

**Table 3.12 Monthly Employment Pattern of Females in PTR (1997-'98)**

Month	Fishing	Casual Labour	Agriculture	Firewood collection	NTFP Collection	Others	Out of station	Unemployed
April	3.0	9.7	0.0	3.3	0.0	0.0	4.3	9.7
May	6.5	6.7	2.5	7.5	0.0	0.0	0.0	7.8
June	5.3	8.3	2.8	9.8	0.0	0.0	0.0	3.7
July	4.7	11.3	3.3	8.7	0.0	0.0	0.0	3.0
August	4.2	7.5	5.3	10.5	0.0	0.0	0.0	3.5
September	8.0	5.0	4.2	4.3	0.0	0.0	0.0	8.5
October	2.5	4.8	4.0	7.2	0.0	0.0	2.5	10.0
November	2.2	5.2	5.2	7.3	0.0	5.0	0.0	4.5
December	4.7	4.0	10.5	9.3	0.0	0.0	0.0	2.5
January	0.3	6.3	12.7	4.3	0.0	1.0	0.0	6.3
February	0.0	4.0	4.5	4.2	0.8	4.3	2.2	8.0
March	1.0	1.5	5.0	7.3	0.0	5.2	5.0	5.0
Total	42.3	74.3	60.0	83.8	0.8	15.5	14.0	72.5
Mean	3.5	6.2	5.0	7.0	0.1	1.3	1.2	6.0
SD	2.5	2.7	3.4	2.4	0.2	2.2	1.9	2.7

To sum up:

Both the communities are highly dependent on forests for their livelihood. Both communities put together, nearly 64 percent of their employment comes from forest-related activities. This is true even if we consider both communities separately. However, the nature of dependence shows some differences between the two. In general, for *Mannans* the primary source of livelihood is fishing, whereas it is firewood and NTFP collection for Paliyans. On average Mannans spent 43 percent of their time on fishing, whereas Paliyans spend only 8 percent. Different occupational groups can be identified in the area such as fishermen, agriculturists, firewood collectors, NTFP collectors, casual labourers and others. All these groups depend on fishing, but at varying degrees. The fishermen group depends on fishing for about 70 percent of their time; firewood collectors 4 percent, casual labourers 7 percent, agriculturists 9 percent, and others 33 percent. In the case of males dependence is nearly 38 percent and in the case of females it is 12 percent. All groups taken together, we find that the highest proportion of time (25 percent) is devoted for fishing. Hence among the different options of livelihood available to the tribesfolk, fishing is the most important. This dependence is crucial in terms of biodiversity, because, as explained earlier, the unique and fragile aquatic ecosystem in the areas may be threatened by fishing. The nature of fishing in the area by the tribesfolk and its impact on the aquatic biodiversity is examined in the ensuing sections.

## 4. Analysis of Fishery Activities in the Tiger Reserve

### Fishing areas

The fishermen in Periyar Tiger Reserve commonly go for fishing in two sites viz., Anchuruli and Nellikkampetty. Anchuruli is nearly five km from the Labakkandam settlement while Nellikkampetty is about 10 km away. About 65-70 percent of the fishermen go to Nellikkampetty. It is easy from Nellikkampetty to go upstream, an endeavour, which fishermen usually undertake in the summer season. The common sites in Anchuruli are Edapalayam, Para valavu, Pooyathotty, Aruliyoda, Nellippara, Kozhikkannam, and Chakkuppara. In Nellikkampetty, Poovarasu, Aruvi, Swamikayam, Chennippara, and Mullakkudi *thuruthu* are the sites for fishing. A fishing unit comprises a fisherman, a raft, and nets with mesh size of 5 cm, 7 cm, and 10 cm. During the summer season, the number of persons per fishing unit may increase to two, as the unit travels to more distances along the lake and the upstream (towards Mullakudi). The presence of obstacles in the lake (mainly the stumps of trees) prevents the use of active gears; the fishermen therefore use only passive gears such as simple gillnets. The usual size of the net is 2m x 10-30m. Fishermen buy second-hand nets from Kumarakom (Kottayam), at the rate of Rs 300 per kg. Normally nets last for only six months, as they become unserviceable due to wear and tear caused by the tree stumps in the lake. The raft is made up of five to six bamboos of 8 ft to 12 ft long. On an average a fisherman carries 6 kg of nets, though they need at least 10 kg for efficient operation. In order to darken<sup>9</sup> the nets, they use the bark of the *Thuthi*<sup>10</sup> tree. The large mesh nets (10 cm) are operated during the rainy season, whereas all three will be operated in the other seasons. Box 4.1 shows the intensity of use of crafts and gears by the tribal fishermen in the different months of the year.

**Box 4.1 Intensity of Crafts and Gears Used for Fishing in Different Seasons**

Month	Craft	Nets: mesh size			Hook & line
		5.0 cms	7.0 cms	9.0 cms	
April	✓✓	✓✓	✓✓	✗	✓
May	✓✓	✓✓	✓✓	✗	✓
June	✓✓	✓	✓	✓	✓✓
July	✓✓	✓	✓	✓✓	✓✓
August	✓✓	✓	✓✓	✓✓	✓✓
September	✓✓	✓✓	✓✓	✓✓	✓✓
October	✓✓	✓✓	✓✓	✓✓	✓
November	✓✓	✓	✓	✗	✓
December	✓✓	✓	✓	✗	✗
January	✓✓	✓✓	✓✓	✗	✓
February	✓✓	✓✓	✓✓	✗	✓
March	✓✓	✓✓	✓✓	✗	✓
Key	✓✓ - Intensively used		✓ - Moderately used		✗ - Rarely used

## Landing details

The main commercial species caught from the Periyar Lake include both exotic and endemic species. The exotic species are the common European carp locally known as Gold Fish (*Cyprinus carpio communis*) and Tilapia (*Oreochromis mossambicus*). The endemic species are the threatened cyprind species Mahseer<sup>11</sup>, locally known as *Kuyil (Tor khudree)* and Mahasaal locally known as *Kooral (Puntius curmuca)*. Table 4.1 shows the monthly total landing at PTR. The total catch was 32,007 kg during 1997-'98. It was more than twice the catch in 1995-'96 (Arun, 1997)<sup>12</sup>. At the market rates, the total value of catch came to nearly Rs 12,00,000. Fishes are sorted mainly into two categories. Category I consists of large-sized fishes viz. the *T. khudree* (Kuyil/Mahseer) and *C. carpio* (Goldfish/ European common carp). Category-II consists of relatively small-sized fishes such as *O. mossambicus* (Tilapia) and *P. curmuca* (Kooral). The monthly catch varies from a low of 853 kg in December to a high of 5049 kg in July for category I; for category II the catch varies from 276 kg in June to 1076 in July. As may be seen from the Tables 4.1 and 4.2, the major share of the category I consists of *C. carpio*, whereas *O. mossambicus* constituted the lion's share in category II. In other words, the exotic species dominated in the landing in both the categories. The share of endemic fish *T. khudree* is high during the months of September and October with 51 percent (695 kg) and 61 percent (1676 kg) respectively in the first category. The highest catch of *T.khudree* occurs in October, whereas the lowest is in December (362 kg). The share of *P.curmuca*, the other threatened fish exploited commercially ranges from 7 percent (75 kg) to 29 percent (102 kg) in category II. In the case of the main exotic species, *C.carpio*, the catch varies from a low of 657 kg in September to a high of 3438 kg in July, whereas the catch of *O.mossambicus* varies from a low of 229 kg in June to 941 kg in October (Fig. 4.1and 4.2).

The highest catch is obtained during the monsoon season (Fig. 4.3). During the monsoon, expecting good harvests, a large number of the tribesfolk venture into fishing. *Paliyans* also enter fishing during this season. There is high correlation between number of persons engaged, total catch, and rainfall (Box 4.2). Figure 4.4 and Table 4.4 show the relation between the number of fishermen and the catch. On an average 23 persons were daily engaged in fishing during the peak month of July whereas it was very low in the December (8.3).The variation in the number of persons engaged daily is very low during July. The low fishing activity during December may be due to the arrival of the peak agricultural season.

### Box 4.2 Correlation between rainfall & fish catch

	Rain fall	No. of Persons/Day
No. of Persons/Day	0.69	
Total Catch	0.70	0.67

## Marketing

Nearly 95 percent of the tribal fishermen sell their catch to private traders. Four traders operate in the area. There are two landing points. Those who are engaged in fishing at Anchuruli sell at the Anchuruli road site near the settlement. From the Nellikampetty



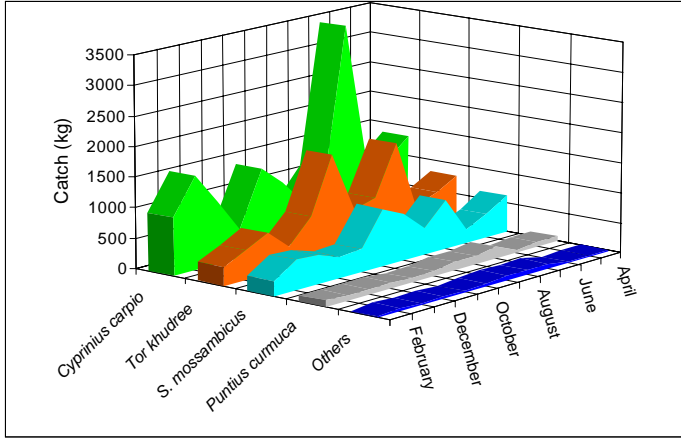
Table 4.1 Commercial Fish Catch from Periyar Lake (1997-'98)

Month	Tor kludree (Mahseer)	Cyprinus carpio (Goldfish)	Category I	Puntius curmucamossambicus (Kooral)	O. mossambicus (Tilapia)	Others	Category II	Total Catch
	(A)	(B)	(C) = (A) + (B)	(D)	(E)	(F)	(G) = (D) + (E) + (F)	(H) = (C) + (G)
April	793.9	1323.1	2117.0	80.1	608.9	16.0	705.0	2822.0
May	619.7	1005.3	1625.0	77.6	385.2	12.2	475.0	2100.0
June	475.4	1069.6	1545.0	39.4	228.7	7.9	276.0	1821.0
July	1611.4	3437.6	5049.0	186.5	817.8	71.7	1076.0	6125.0
August	783.8	1098.2	1882.0	129.5	442.0	63.5	635.0	2517.0
September	694.6	657.4	1352.0	137.1	764.6	77.3	979.0	2331.0
October	1675.7	1066.3	2742.0	75.3	941.1	37.6	1054.0	3796.0
November	748.7	1390.4	2139.0	65.2	377.8	16.1	459.0	2598.0
December	361.5	491.5	853.0	95.8	351.6	33.6	481.0	1334.0
January	669.5	1046.5	1716.0	82.2	475.4	19.4	577.0	2293.0
February	480.6	1551.4	2032.0	90.6	497.0	48.3	636.0	2668.0
March	303.8	950.8	1251.0	101.8	238.7	10.5	351.0	1602.0
Total	9218.5	15088.1	24303.0	1161.1	6128.7	414.2	7704.0	32007.0
Mean	768.2	1257.3	2025.3	96.8	510.7	34.5	642.0	2667.3
SD	439.3	745.1	1070.8	38.6	228.0	25.1	267.3	1260.8
Daily	25.6	41.9	67.5	3.2	17.0	1.2	21.4	88.9

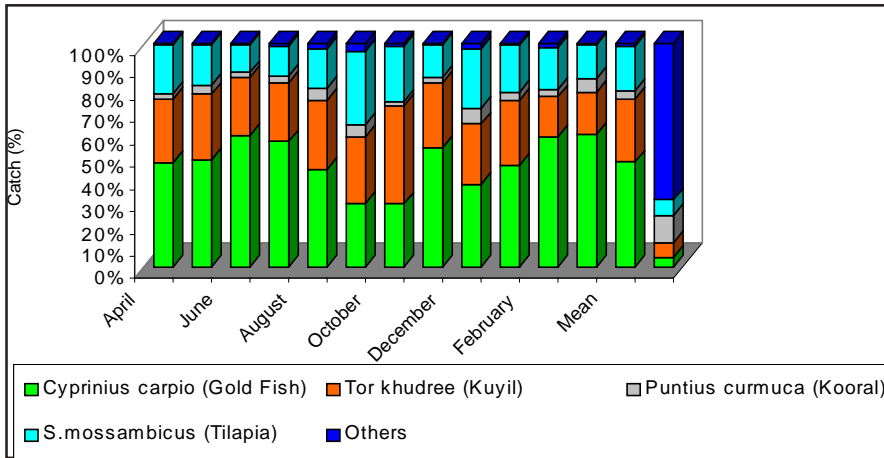
Table 4-2 Proportion of Different Species in the Landing

Month	Tor kluudree (Kuyil)	Cyprinus carpio (Gold Fish)	Category I	Puritus curmuka (Kooral)	O. mossambicus (Tilapia)	Others	Category II
	(A)	(B)	(C)= (A)+ (B)	(D)	(E)	(F)	(G)= (D)+ (E)+ (F)
April	38%	63%	100%	11%	86%	2%	100%
May	38%	62%	100%	16%	81%	3%	100%
June	31%	69%	100%	14%	83%	3%	100%
July	32%	68%	100%	17%	76%	7%	100%
August	42%	58%	100%	20%	70%	10%	100%
September	51%	49%	100%	14%	78%	8%	100%
October	61%	39%	100%	7%	89%	4%	100%
November	35%	65%	100%	14%	82%	4%	100%
December	42%	58%	100%	20%	73%	7%	100%
January	39%	61%	100%	14%	82%	3%	100%
February	24%	76%	100%	14%	78%	8%	100%
March	24%	76%	100%	29%	68%	3%	100%
<b>Mean</b>	<b>38%</b>	<b>62%</b>	<b>100%</b>	<b>16%</b>	<b>79%</b>	<b>5%</b>	<b>100%</b>

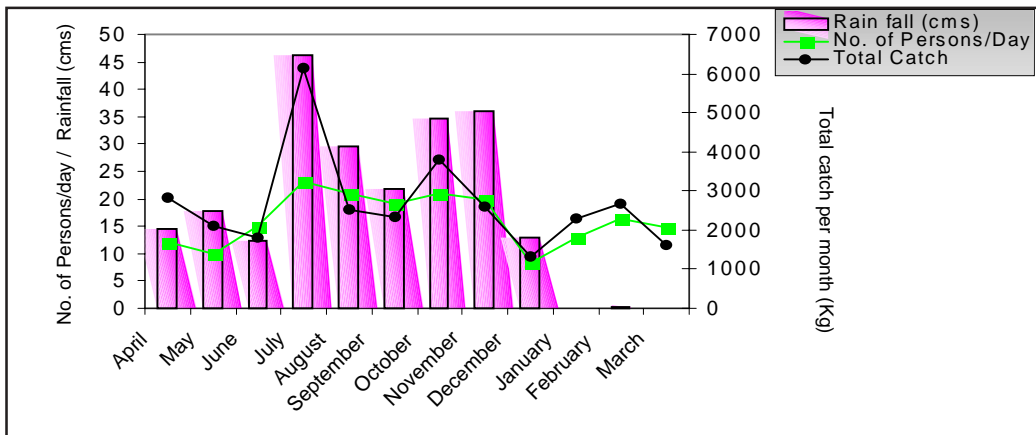
**Figure 4.1 Monthly Species-wise Landing in PTR (1997-'98)**



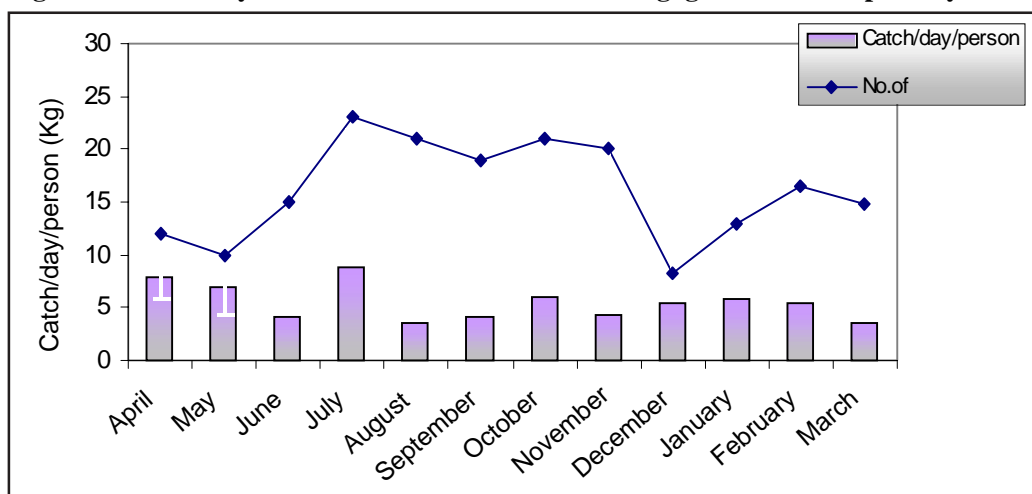
**Figure 4.2 Comparison of Fish Catch Composition from PTR with Experimental Catches (Percentages to Total)**



**Figure 4.3 Relation between Rainfall and Fishing**



**Figure 4.4 Monthly Variation in No. of Fishermen Engaged and Catch per Day**



**Table 4.3 The Share of Each Species in the Total Catch (1997-'98)**

Month	Torkhudree (Mahseer)	Cyprinius carpio (Gold Fish)	Puntius curmuca (Kooral)	O.mossambicus (Tilapia)	Others	Total
April	28.1%	46.9%	2.8%	21.6%	0.6%	100.0%
May	29.5%	47.9%	3.7%	18.3%	0.6%	100.0%
June	26.1%	58.7%	2.2%	12.6%	0.4%	100.0%
July	26.3%	56.1%	3.0%	13.4%	1.2%	100.0%
August	31.1%	43.6%	5.1%	17.6%	2.5%	100.0%
September	29.8%	28.2%	5.9%	32.8%	3.3%	100.0%
October	44.1%	28.1%	2.0%	24.8%	1.0%	100.0%
November	28.8%	53.5%	2.5%	14.5%	0.6%	100.0%
December	27.1%	36.8%	7.2%	26.4%	2.5%	100.0%
January	29.2%	45.6%	3.6%	20.7%	0.8%	100.0%
February	18.0%	58.1%	3.4%	18.6%	1.8%	100.0%
March	19.0%	59.3%	6.4%	14.9%	0.5%	100.0%
<i>Mean</i>	<i>28.1%</i>	<i>46.9%</i>	<i>4.0%</i>	<i>19.7%</i>	<i>1.3%</i>	<i>100.0%</i>
<i>Experimental</i>	<i>7%</i>	<i>4%</i>	<i>12%</i>	<i>7%</i>	<i>70%</i>	<i>100.0%</i>

area, fishermen come to the Thekkady junction to sell fish. From Anchuruli, fishermen arrive at the selling point (Anchuruli road – in the settlement) from 8:00 hrs onwards. Trading lasts hardly an hour. Then the traders go to the Thekkady Junction to buy fish from those coming from Nellikkampetty. The traders in turn sell in the market or resort to door-to-door sales. The price offered at the landing is Rs 30 per kg for category I and Rs 25 per kg for category II. All traders offer the same price to the fishermen.

**Table 4.4 No. of Persons Engaged in Fishing in PTR (1997-'98)**

<b>Months</b>	<b>Total No. of persons engaged*</b>	<b>Average No. of persons engaged in a day</b>	<b>Daily Catch per person (kg)</b>
April	360	12.0	7.8
May	300	10.0	7.0
June	450	15.0	4.0
July	690	23.0	8.9
August	630	21.0	4.0
September	570	19.0	4.1
October	630	21.0	6.0
November	600	20.0	4.3
December	249	8.3	5.4
January	387	12.9	5.9
February	495	16.5	5.4
March	444	14.8	3.6
<i>Mean</i>	<i>484</i>	<i>16.1</i>	<i>5.5</i>

\*Number of fishermen reported at the landing in a month.

But the actual number of individuals engaged in fishing may be lower or higher depending on the frequency of fishing trips.

Each trader has a fixed number of fishermen attached to him. The traders offer advances to fishermen, which is how they establish the bondage. The fishes collected from the lake are completely sold locally. The retail-selling price of fishes varies with size and species. Generally Mahseers (*T.khudree*) command good price up to Rs 60 per kg, whereas European Carp (*C.carpio*) and Tilapia (*O.mossambicus*) are sold at Rs 45 per kg and Rs 30 per kg respectively in the retail market. Though marine fishes are available at lower prices (Rs 20-30 per kg), there exists great demand for the fishes from the lake in the local market. Since Periyar is a tourist resort, the demand from the hotels is also high. There is only one layer of intermediaries in the fish-trading activity in Periyar. The average margin for the trader is about 25 percent of the final price.

### **Fish biology**

The fishery activity *prima facie* shows conflict as well as consistency between conservation of aquatic biodiversity and sustainability of fishery in PTR. Conflict exists because of

- (i) commercial exploitation of the endemic/threatened fishes, and
- (ii) the presence of exotic species in the lake.

The positive aspects of the fishery are that

- (i) it supports the livelihood of the majority of *Mannans*,

- (ii) it makes possible the commercial exploitation of the exotic species together with that of the endemic and threatened species.

The threats to the native and other species come in two ways.

- (i) from the presence of exotic species,
- (ii) from commercial exploitation. Consistency exists because, along with endemic species, the exotic species are also exploited, as a result of which the threats to the endemic fishes present in the system are reduced to a certain extent.

The question of how intense the conflict is can be answered only by analysing separately different aspects such as biology, and dietary and breeding patterns of the commercially exploited species.

### ***Diet of fishes***

Arun (1997) noted that six categories of food items viz. algae, terrestrial insects, aquatic insects, plankton, detritus, crustaceans and molluscs, were the major food bases on which the fishes in Periyar Lake and streams rely heavily. A few species of fishes depend on the same food items, i.e., there are overlaps among fish species regarding diet. Of the possible 325 species combinations (27 species among themselves), about 8 percent of the combinations (among different species) show higher levels of overlaps. A high overlap implies competition for the same type of food among these species. Arun (1997) also noted that some of the endemic and/or threatened fishes show medium to high diet overlaps. The exotic species, viz. the European carp (*C. carpio*) and Tilapia (*O. mossambicus*) which are well known for their fast growth, high fecundity, and easy establishment in alien waters also show considerable dietary overlaps with endemic and threatened fishes in the system. Of the possible 24 combinations with native species, Tilapia (*O. mossambicus*) showed 13 high and medium diet overlaps (Box 4.3). Of these, the combination with the endemic and threatened fishes *Lepidopygopsis typus* and *Heteropneustes fossilis* shows higher overlaps of > 65 percent. In the case of European Carp (*C. carpio*) there are medium to high overlaps for 16 combinations. The overlaps are very high between *C. carpio* and *T. khudree* (71 percent) and *P. curmuca* (72 percent). These facts show that the exotic species compete with the native species, especially the commercially exploited species, in terms of food. There is also the possibility of high overlaps in terms of space (i.e., habitat overlap) since these two exotic species are abundant in the lake (Table 2.1). Thus the presence of exotic fishes Tilapia and European Carp, which have omnivorous feeding habits, might seriously affect the existence of highly sensitive endemic/threatened fishes of Periyar which are highly specific on breeding and feeding habits (Arun, 1997).

### ***Breeding of commercially exploited species***

In this section analysis is made of the breeding pattern of commercially exploited species in PTR such as *T. khudree*, *C. carpio*, *P. curmuca*, and *O. mossambicus* and the impact of fishery activities on it. The major parameters analysed here are breeding season, maturity, and sex ratio.

**Box 4.3 Possible Species Combinations with High and Medium Diet Overlap between Exotic and Native Fishes**

Species Combinations	Overlap value	
	Vs <i>C. carpio communis</i>	Vs <i>Oreochromis mossambicus</i>
<i>Bhavana australis</i>	0.49	0.48
<i>Noemacheilus denisoni</i>	0.56	0.52
<i>N. guentheri</i>	0.48	0.46
<i>N. keralensis</i>	0.35	—
<i>Travancoria jonesi</i>	0.50	0.51
<i>Channa gachua</i>	0.39	0.40
<i>Lepidocephalus thermalis</i>	0.45	0.37
<i>Crosscheilus periyarensis</i>	0.37	0.56
<i>Cyprinus carpio communis</i>	—	0.51
<i>Oreochromis mossambicus</i>	0.51	—
<i>Lepidopygopsis typus</i>	0.49	<b><u>0.68</u></b>
<i>Puntius curmuca</i>	<b><u>0.72</u></b>	0.46
<i>P. ophioccephalus</i>	0.62	0.59
<i>Tor khudree</i>	<b><u>0.71</u></b>	0.41
<i>Heteropneustes fossilis</i>	0.62	<b><u>0.68</u></b>
<i>Mastacembelus armatus</i>	0.38	—

Underlined figures show higher overlaps

Source: Arun (1997)

**Endemic/threatened species**

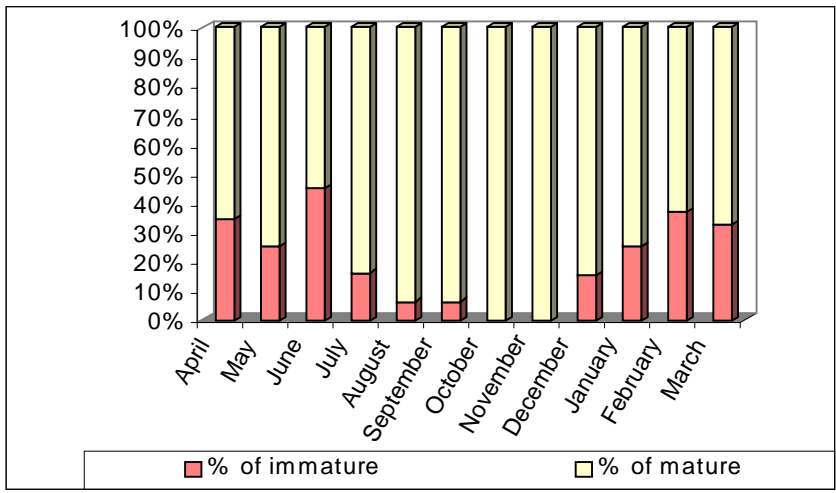
***Tor khudree* (Mahseer – Kuyil)**

*Mahseer* is one of the most demanded table fish in PTR. The landing data show that the maximum catch is in October. The lean months are during December to June. Unlike other species, the arrival of *Mahseer* during the peak monsoon is relatively low. This may be because of the tendency of this fish to migrate upstream during monsoon leaving turbid waters, for feeding and breeding (Desai, 1994; Kulkarni and Ogale, 1979). The size of the fish also varies with season. The minimum and the maximum length of the samples arrived were 17.2 cm and 49.5 cm respectively. The weight of samples ranged from 90 gm to 750 gm. The analysis of collected samples shows that during October and November no immature specimens were encountered. On an average 20.8 percent of the samples were immature. There were also seasonal differences in the pattern of immature samples (Fig 4.5). The maximum length and weight of immature samples encountered were 21.9 cm and 125 gm respectively whereas the minimum length and weight of mature samples were 17.2 and 90 gm. Thus on a rough and ready basis, it may be said that, *T.khudree* in PTR matures when it achieves a length between 17.2 and 22 cm and weight between 90 gm and 125 gm. Fig.4.6 shows the average length and weight of samples collected in different months.

**Box 4.4 Impact of Introduction of Exotic Fish Species on Native Fishes**

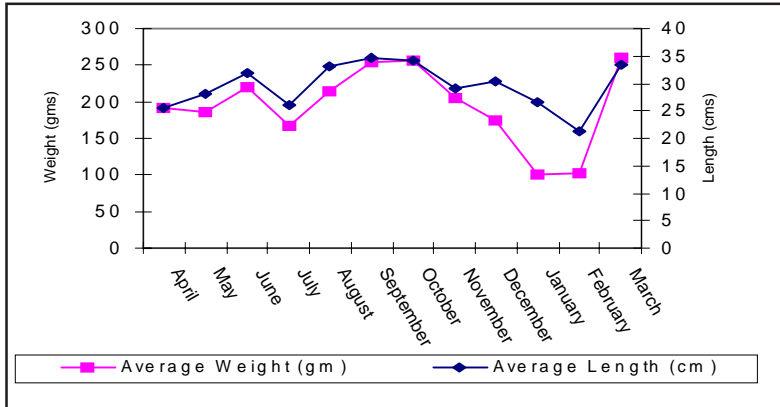
Despite an already rich diverse fish genetic resource of India more than 300 exotic species have been introduced into the country (Jingran, 1989). The general tendency during and after the 1950s to enhance the fish production in the inland water bodies is introduction of exotic species like Tilapia and European Carps. This has substantially augmented the fish production in India. (Sreenivasan, 1991) and other parts of Asia (de Silva, 1985; 1987; Fernando and Holick, 1991). But there is no consensus of opinion among the experts on these introductions. Some believe that these introductions have ruined the native fish fauna, while others think it has never affected the native fish diversity (Sreenivasan, 1991). Destruction of endemic haplochromine fishery has taken place in Lake Victoria due to the introduction of Nile perch (*Lates nilotica*). These introductions done with the intention of augmenting fish production to provide fish ('protein') cheaply for local people have in fact not only destroyed the whole indigenous fishery of the lake but also created a situation by which the available indigenous fishes have become an expensive commodity (Barel et al, 1985; Witte et al 1992; Owuer, 1996). Similarly the populations of the once plentiful and the major food fish of the Himalayan region, *Schizothorax richardsonii* – the snow trout or Himalayan trout - declined sharply ever since the introduction of common carp, the *Cyprinus carpio*, in the late 1950s (Qudri, et al, 1983). The introduction of *O.mossambicus* for weed and insect control in Californian reservoirs has affected the native ichthyofauna. In Kyle reservoir in Zambia, a valuable local species *Paretopus petite* has been eliminated from the ecosystem (Lamarque, et al, 1975). The apprehensions about Tilapia affecting the native ichthyofauna in India seem to be valid considering these experiences. Tilapia has dominated and virtually eliminated all other fishes including the stocked Gangetic carps in a number of reservoirs in Tamil Nadu (Sugunan, 1995). In Kabani reservoir Tilapia has adversely affected indigenous *Cirrhinus reba* by decreasing the catch by 20 to 70%.

**Figure 4.5 Monthly Vairation in the Percentage of Mature and Immature Fishes**



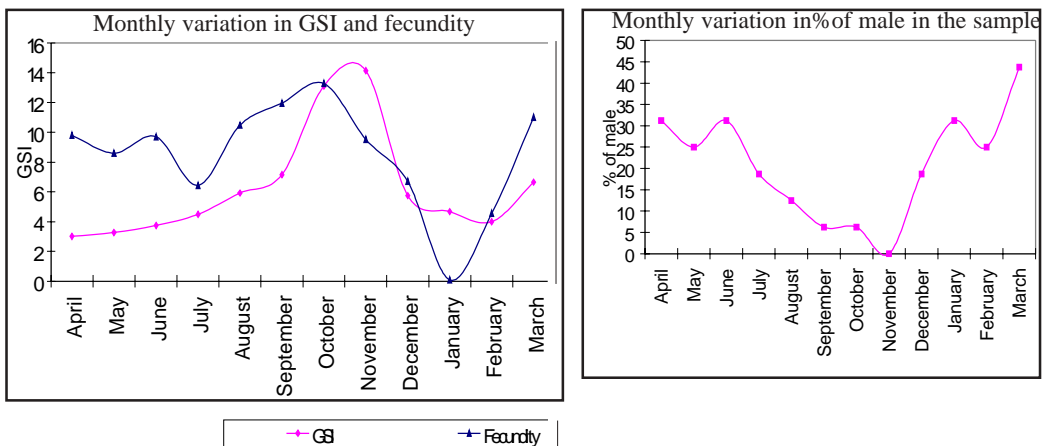


**Figure 4.6 Monthly Variation in Average Length and Weight**



The Gonado Somatic Index (GSI) of *T.khudree* shows a distinct peak in October-November (Fig. 4.7). The same season coincides with the very low percentage of males and immature samples. The fecundity graph shows a peak in October, which goes on declining till February. This implies that the fishes mature and release eggs in the October-December season (Fig 4.7). The relationship between rainfall and GSI also is positive (Fig 4.3). The peak of GSI coincides with the withdrawal of monsoon (September-November)<sup>13</sup>. There are also similar reports regarding the breeding season. These factors indicate that the spawning season of *T. khudree* is the October-November period. The relation between weight, fecundity and weight in log form is shown in Box 4.5 and Fig. 4.8.

**Figure 4.7 Analysis on *T. khudree*: GSI, Fecundity, and Percentage of Male**



The breeding analysis clearly shows that *T.khudree* generally breeds in October-November season. After July (the first rains) the breeding activities begin; they attain a peak in October and is completed in December. The presence of fully mature and spent females in the samples collected during October-November confirms this conclusion. The high correlation between monsoon and GSI suggests that rainy season induces spawning. The percentage of

#### Box 4.5 Relation between Weight, Length, and Fecundity of *T. khudree*

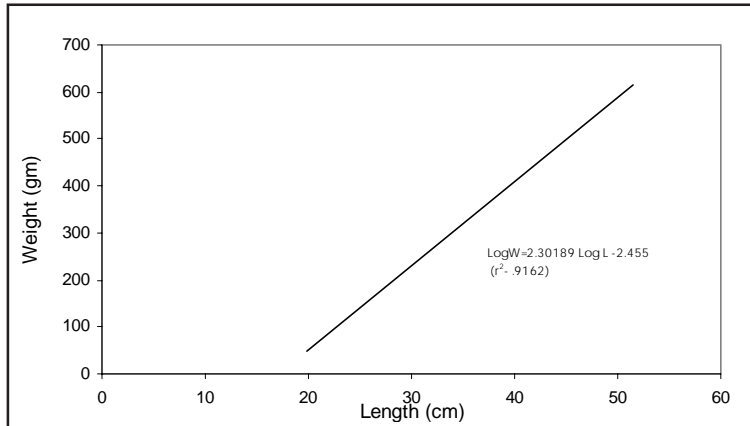
$$\text{Log } W = 2.3019 \text{ Log } L - 2.455 \quad (r^2 = .9162)$$

$$\text{Log } F = 1.7041 \text{ Log } L + 1.4248 \quad (r^2 = .7125)$$

$$\text{Log } F = 1.0973 \text{ Log } W + 1.4391 \quad (r^2 = .9211)$$

W – Weight L – Length F- Fecundity

Figure 4.8 Length-weight Relation



immature fishes encountered is also low in these seasons. During summer the fishermen prefer upstream than the lake for fishing. The fishermen report that about 40 percent of the collection during the summer season accounts for the fishes from the upstream (*T.khudree* is relatively abundant in streams: Table 2.1)

The sex ratio of the samples collected shows a dominance of female fishes. The presence of male fishes in the catch is high during the February- May season (Fig. 4.7). The male fishes are virtually absent during the breeding seasons. Two possible explanations exist for this phenomenon. (i) Owing to the inherent small size (the average length and weight of males sample was 27.2 cm and 295 gm respectively whereas that for the females it was 32.7cm and 365 gm respectively) it escapes from the nets<sup>14</sup>. Higher number of male fishes was encountered in the season when small mesh size nets were operated (Box 4.1). (ii) Because of heavier weight and larger size the females may become sluggish during the breeding season, as a result of which they get trapped in the nets. The catch composition shows that the highest catch of *T. khudree* is during its breeding season. Fishermen use intensively all types of nets during October, a practice which seldom spares any size classes of the fishes. The effect of these activities on the stock of fish is highly destructive.

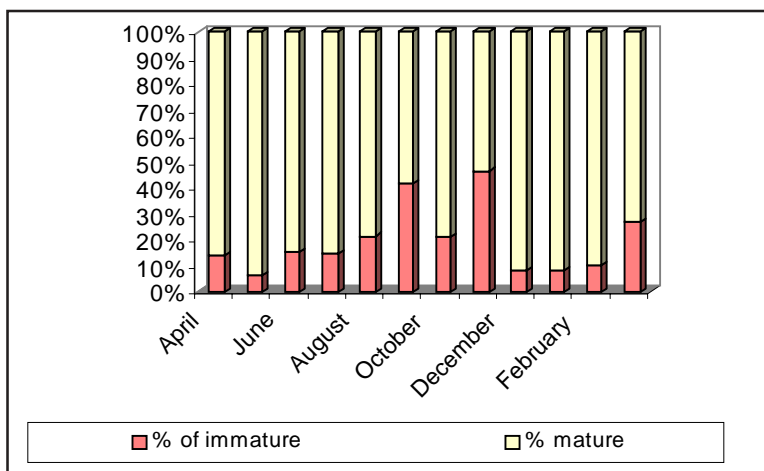
The experimental catch data presented by Arun (1997) show that *T. khudree* accounts for about 7 percent of the samples. But the landing data show that *T.khudree* accounts for about 18 to 44 percent. This finding raises doubts about the impression of over-exploitation of this species.

### *Puntius curmuca* (Kooral)

*Puntius curmuca* is one of the medium-sized fishes caught from PTR Lake. As already mentioned it is one of the most endemic and threatened species in the system. Since the sizes of *P. curmuca* and *O. mossambicus* are identical, they are sold together as category II. In terms of catch the share of this species is very low. In the total catch, it ranges between 2 to 7.2 percent per month with a mean of 4.0 percent. Considering the category II alone, the share ranges between 7 to 29 percent. In absolute terms the catch ranges between 39.4 kg in April to a maximum of 186.5 kg in July. The total catch during 1997-'98 was 1161 kg, with monthly mean value of 96.8 kg. The experimental catch data collected during his study by Arun (1997) show that *P. curmuca* accounted for nearly 12 percent (Fig. 4.2). The average share of this species in commercial catches shows a lower figure of 4.0 percent. Thus, this species is found harvested in a sustainable manner<sup>15</sup>.

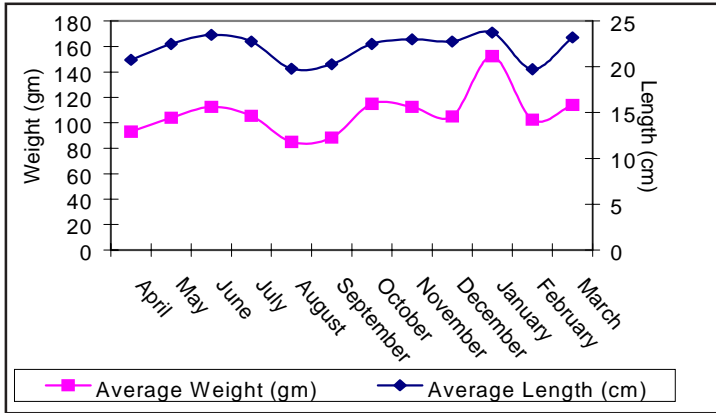
Nearly 25 percent of the total samples collected were of male fishes. On an average, the highest share of male fishes was encountered in January and May (45 percent) and the lowest in November (6.25 percent; Fig. 4.7). The monthly maturity pattern of fishes is given Fig. 4.9. No definite pattern is visible in the percentage of immature fishes. In contrast to other species, complete matured fishes were meagre in samples collected for this species. The share of immature fishes was the highest in the month of November and the lowest in May and December. From the average length and weight pattern of the sample fishes, we find that large fishes were caught in the months of March, June, and December (Fig. 4.10). The average length and weight of the *P. curmuca* were 22 cm and 107.5 gm.

**Figure 4.9 Monthly Vairation in the Mature and Immature Fishes**



The GSI graph shows three peak seasons, March, July, and November, showing absence of definite spawning season (Fig. 4.11). The lowest number of immature fishes was also obtained during these peak months. No fully spent fishes were encountered in the sample collections. Thus it is seen that the fish releases eggs in batches at intervals. Sivakami (1982) has also recorded similar observations for *Puntius dorsalis*.

**Figure 4.10 Monthly Vairation in Average Weight and Length**



**Box 4.6 Relation between Weight, Length, and Fecundity of *Puntius curmuca***

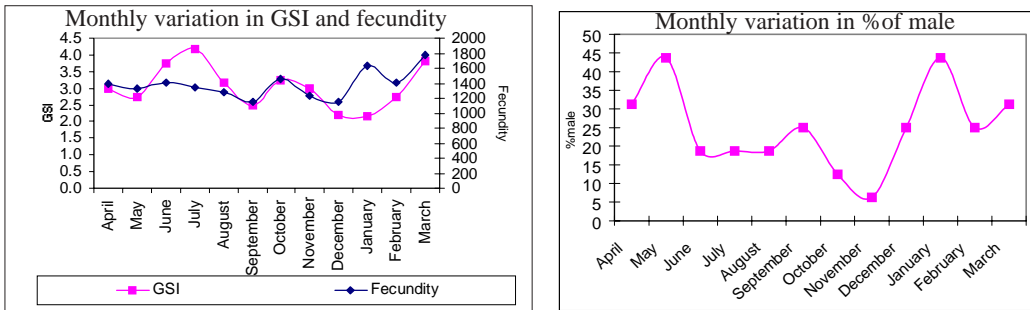
$$\text{Log } W = 1.1114 \text{ Log } L - 1.229 \quad (r^2 = .8606)$$

$$\text{Log } F = 0.7826 \text{ Log } L + 4.7918 \quad (r^2 = .6296)$$

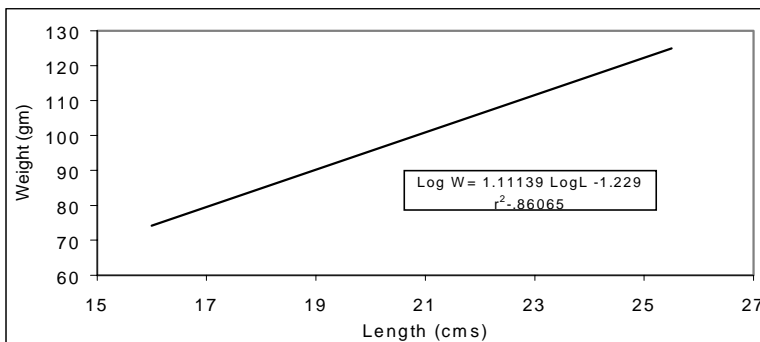
$$\text{Log } F = 0.6406 \text{ Log } W + 4.2299 \quad (r^2 = .6576)$$

W – Weight L – Length F- Fecundity

**Figure 4.11 Analysis on *Puntius Curmuca*: GIS, Fecundity, and Percentage of Males**



**Figure 4.12 Lenth and Weight Relation**



Though the sex ratio shows the dominance of female fishes, the ratio compares favourably with those of other fishes that are collected commercially. The average size of the male fishes is lower than the average size of female fishes, thereby showing the general pattern. The relationship between the catch and the gears used doesn't show any significance i.e., the highest catch does not always coincide with the intensive use of small-sized gears.

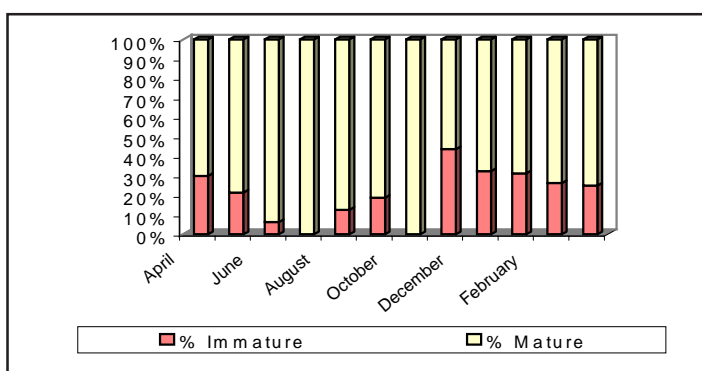
### Exotic / introduced species

#### *Cyprinus carpio communis* (Gold fish)

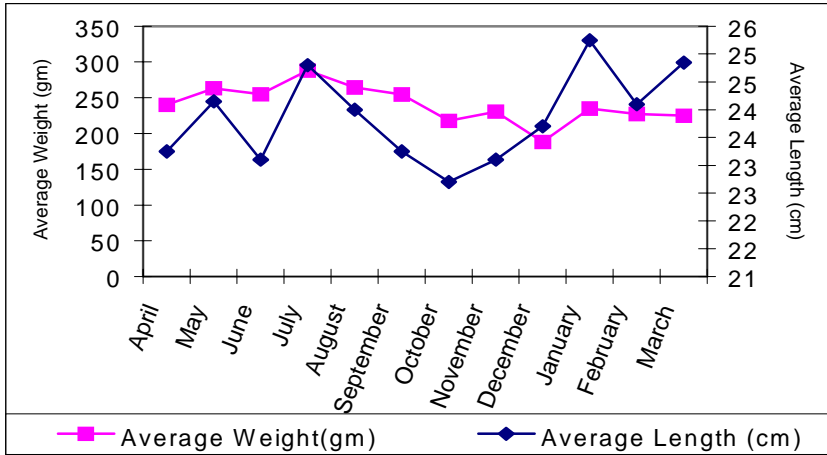
In terms of catch, European carp (*C. carpio*) contributes the highest share, nearly 50 percent of the total catch. The highest catch is recorded in the month of July (3438 kg), which is about 59 percent of the total catch. The lean months were December and September (492 and 657 kg respectively). The average monthly production is 1257 kg. The average length and weight of collected samples show only slight variations. Larger-sized fishes were collected during July-August season. The mean length and weight of the entire samples were 23.8 cm and 240.8 gm respectively. The maximum and the minimum length and weight of the samples were 43.2 cm and 1190 gm and 20.5 cm and 75 gm respectively. The length pattern of the samples and the gears used have *prima facie* positive relation as the large-sized fishes were collected during July, when larger-sized nets were used.

On an average, about 21 percent of the total sample fishes were immature, with the maximum proportion found in November (Fig. 4.13). All the samples collected during July and November were found to be mature. The maximum length of the immature sample was 26.5 cm with a mean of 22.9 cm, whereas the minimum length of the matured sample was 24.5 cm. Thus with maturity length acquired varies between 22.9 cm and 24.5 cm. About 20 percent of the collected samples were males. The pattern of male samples was also erratic, with the maximum numbers occurring in November and April. No males were observed in the samples collected in January and March. The *C. carpio*'s breeding season based on GSI shows that a high peak in July and a small peak in November (Fig. 4.15). The samples collected between August and December showed spent ovaries. The relationship between length, weight, and fecundity is shown in Box 4.7 and Fig. 4.16.

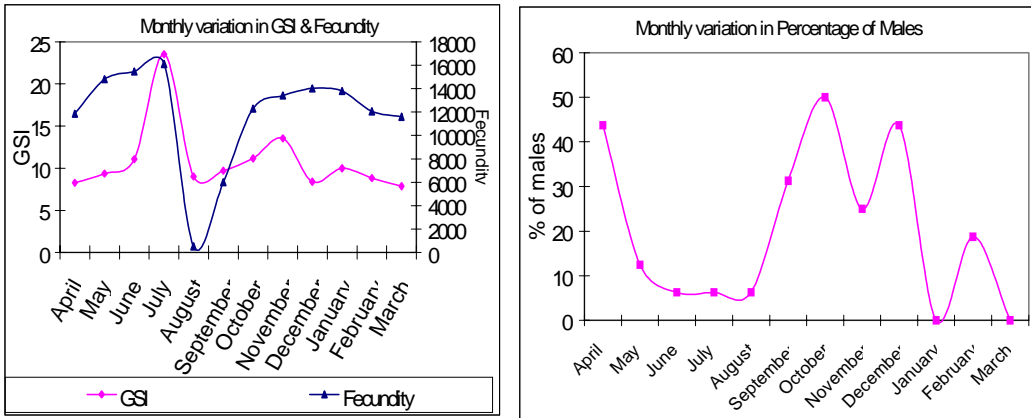
**Figure4.13 Monthly Variation in the Percentage of Mature & Immature Fishes**



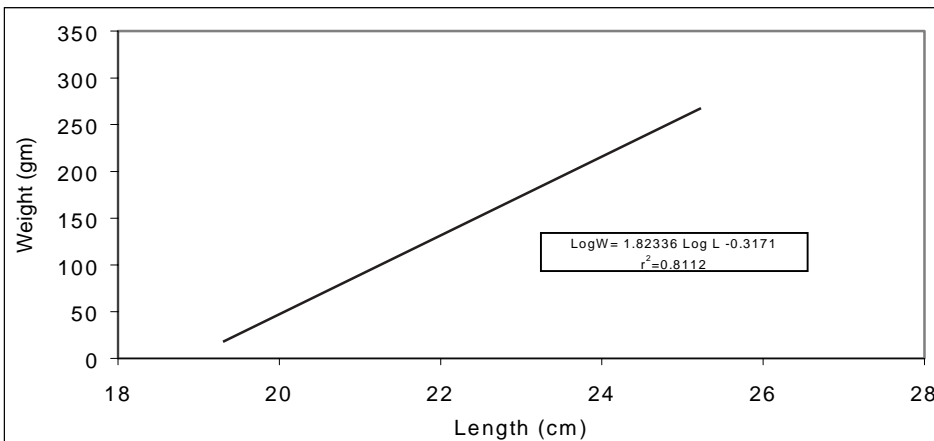
**Figure 4.14 Monthly Variation in Average Length and Weight**



**Figure 4.15 Analysis on *Cyprinus Carpio Communis*: GSI, Fecundity, and % of Males**



**Figure 4.16 Length-weight Relation**



#### Box 4.7 Relation between Weight, Length and Fecundity of *Cyprinus carpio ommunis*

$$\text{Log W} = 1.8234 \text{ Log L} - 0.3176 \quad (r^2 = .8112)$$

$$\text{Log F} = 0.5341 \text{ Log L} + 7.089 \quad (r^2 = .7132)$$

$$\text{Log F} = 0.3962 \text{ Log W} + 7.3352 \quad (r^2 = .6907)$$

W – Weight   L – Length   F- Fecundity

Compared to the average monthly production of 490 kg of *C. carpio* in 1995-'96 (Arun, 1997), the production in 1997-'98 was higher by nearly 3 times (1257 kg). It is difficult to draw a firm conclusion on the rate of exploitation based on these figures. The increase in the catch during 1997-'98 has a positive effect on the income of the fishermen, though it might be nullified because of the higher number of units operated (Average is 16.1; Table 4.4). Even if this were true, the situation poses an alarming situation as the increase in catch is achieved without any stocking. That is, even with intensive harvesting during the breeding season and without even replenishing the stock, the population of *C. carpio* seems to be increasing in the lake. This is a definite threat to the endemic and threatened fishes in the system as this exotic species has the capacity to invade into the habitat and dietary resources of native fishes, thereby setting their existence to risk. The positive effect of the present fishery activities is that they may put some check on the rise in population of *C. carpio*.

#### ***Oreochromis mossambicus* (Tilapia)**

*O. mossambicus* was first introduced into the pond system of the country in 1952, and soon it came to be stocked in the reservoirs of south India. By the end of the 1960s, most of the reservoirs in Tamil Nadu and the Palakkad and Thrissur districts in Kerala were stocked with Tilapia. It is reported that Tilapia matures at 6 cm length at an age of 75 days and breeds at an interval of one month under tropical conditions. The average daily collection of Tilapia from PTR is about 17 kg, with mean production per month of 511 kg. This fish constitutes more than 79 percent of the category II fishes and 19 percent of the total catch. The maximum production is in the month of October (941 kg). During the experimental catch (by Arun, 1997) this species constituted about 7 percent of the total fishes in the lake. Compared to this, the present catch rate shows a higher share. The share of production increased since 1995-'96, when it was about 8 percent. This is a good sign. The production pattern is also related to the type of nets used. The share of Tilapia was high, in general, during the lean months of other large fishes (Table 4.1).

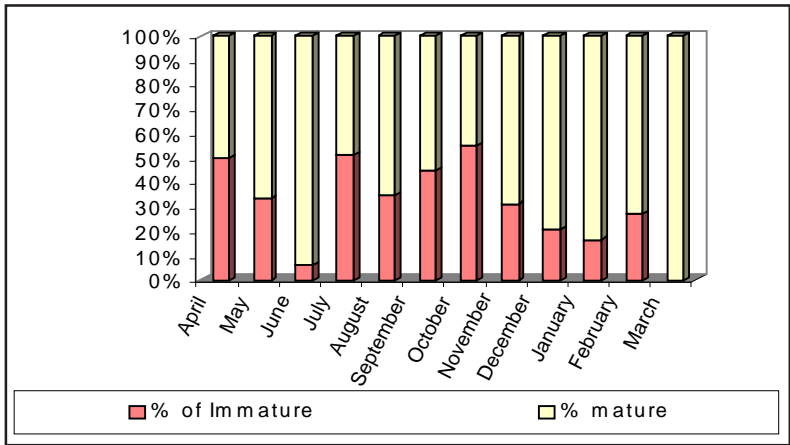
The length of *O. mossambicus* samples collected from PTR, varied between 17 and 24 cm, where as the weight ranged between 100 to 165 gm. But the average length and weight of samples collected of this species show only minimal variation. This revealed a positive relation between the type of nets used and the size of the fishes. The same size classes of catch may be the result of the excessive reproduction and consequent dwarfing. Such an experience has been reported elsewhere too (Sugunan and Sinha, 1997). The increase in the catch compared to that in 1995-'96 may be also due to this factor.

**Box4.8 Relation between Weight Length and Fecundity of *Oreochromis mossambicus***

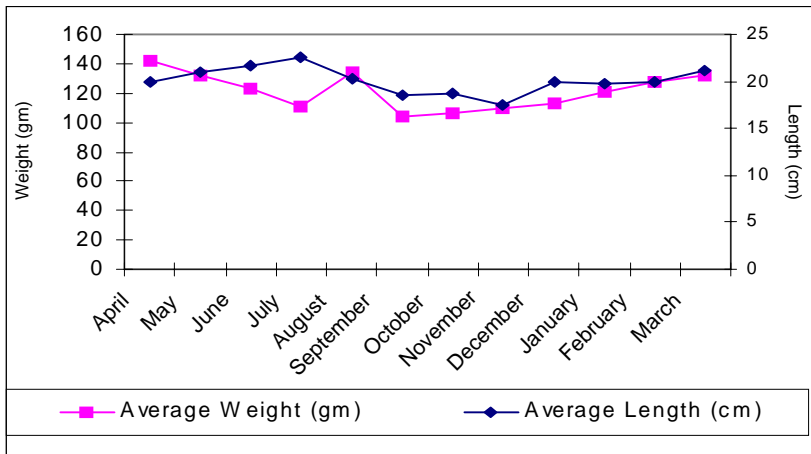
$\text{LOG W} = 2.6701 \text{ LOG L} - 3.3033 \quad (R^2 = .7807)$ $\text{LOG F} = 0.2381 \text{ LOG L} + 5.4594 \quad (R^2 = .4935)$ $\text{LOG F} = 0.1359 \text{ LOG W} + 5.5547 \quad (R^2 = .5538)$ <p>W – WEIGHT    L – LENGTH    F- FECUNDITY</p>
--

On an average 30 percent of the total sample were immature, with a maximum of about 50 percent in April, July, and October (Fig. 4.17). About 39 percent of the collected fishes were males (Fig. 4.20). The breeding pattern shows several peaks with a definite pattern (Fig 4.19) indicating that it is a prolific breeder. The fecundity chart also followed the same pattern. The results of the study were in accordance with those of studies by Aravindan (1975).

**Figure 4.17 Monthly Variation in the Mature & Immature Fishes**

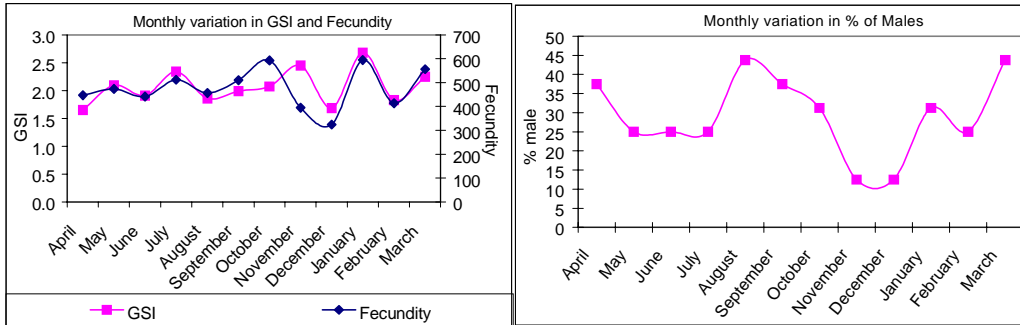


**Figure 4.18 Monthly Variation in Average Length and Weight**

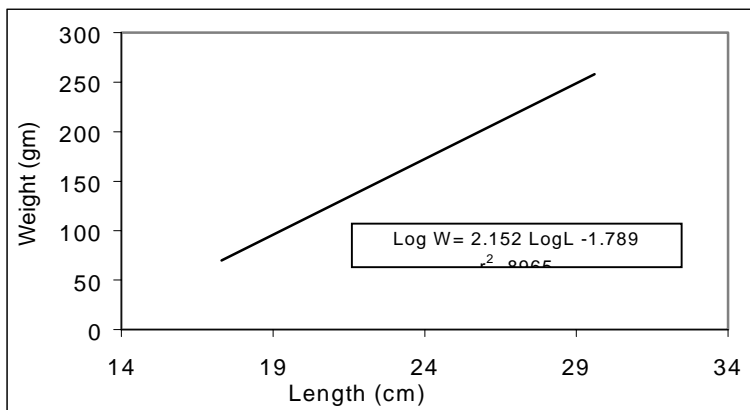




**Figure 4.19 Analysis on *Oreochromis mossambicus*: GIS, fecundity, and % of males**



**Figure 4.20 Length-weight Relation**



### Implications of fishery activities

The literature on *Mahseer (T.khudree)* suggests that the stocks of this species in India and in similar habitats have declined drastically (Johnsing and Negi, 1998). Not only the number, but the size of the fishes too has declined. It is reported that there is a combination of factors for the decline of *Mahseers* in the country. They include unchecked and indiscriminate fishing and destructive fishing methods such as using poison, dynamite, etc (National Commission on Agriculture, 1976). Construction of dams<sup>16</sup> has impeded the migration of *Mahseers* (Desai, 1994), which is an essential condition for their spawning. Mahseers need to reach their favoured spawning grounds, which have to be calm with well-oxygenated water and a bed of sand or gravel. There are also other factors, which separate Mahseers from other commercial fishes. The fecundity of *Khudree Mahseer* is in general very low, and its eggs are capable of sinking in the riverbed. Thus the presence of mud on the bed instead of sand or gravel would destroy the eggs. The hatching period of Mahseers is 5 to 6 times longer than that of the other commercial fishes such as Catla (*Catla catla*) [Kulkarni, 1980]. All these factors show that *Mahseers* are much more vulnerable to all forms of decimation, and priority conservation measures are necessary for their survival.

*Mahseer* attains larger sizes and rank next to *Bagarus bagarius* in terms of size of freshwater fishes. Veteran fishermen in PTR recollect that *Mahseers* weighing more than 50 kg were frequent even two to three decades ago. But the present stock seldom contains such large fishes. The maximum weight of the fish now caught is only less than 2 kg. The type of gears used is positively related to the size of fishes caught; the pattern shows that when the smaller meshes were used for fishing, the percentage of smaller fishes caught was high.

Of the two endemic species commercially exploited in PTR, Mahseer contributes nearly 30 percent of the total catch. Like the experience elsewhere, in PTR too, during monsoon, Mahseer catch is low (except in July). The catch increased towards the end of the monsoon season. The reason might have been as stated earlier, the migratory nature of the fishes to the upstream during the monsoon period. At present the Forest Department strictly warns fishermen not to go to the upstream in the monsoon seasons. But they are free to go upstream after the monsoon season is over; i.e., after late August and/or early September. This might be the reason for higher catch in the later part of the year. Since the spawning season extends till November, a complete closure period of upstream is ideal to protect these species. The highest catch is found always to coincide with the breeding season. This is especially true for the exotic variety *C. carpio*. *C. carpio* has overlaps with the endemic *T.khudree* and *P. curmuca*, whereas the *O. mossambicus* has overlaps with small-sized endemic fishes which are not exploited commercially.

The higher percentage of European Carp found in the commercial catch suggests the existence of an alarming situation with drastic increase in its population. The higher overlap values also suggest the existence of such a situation which invariably affects the population of the two most important fishes in the lake *T.khudree* and *P. curmuca*. The situation seems more severe, if we consider the fact that no stocking has taken place since the introduction. This is because the Forest Department never allowed any type of introductions/stocking in the past two decades.

This forces us to conclude tentatively that increase in population is mainly because of invasion of this species in the lake, though more detailed explorations are needed to confirm this conclusion. One way of tackling this situation is to allow fishing intensively in all seasons in the lake. The danger of such a policy would be that the similar-sized *T.khudree* may also be harvested together with European carps, a consequence that further aggravates situation. Since carps are virtually absent in the upstream and Mahseers are abundant in streams (Table 2.1), fishing in the lake may not be a threat to the entire population of *Mahseers* in the Periyar aquatic system.

The share size of *O. mossambicus* is almost steady in the catch. The share of *O. mossambicus* is very high (nearly 60-80 percent) in the category II, thereby suggesting the presence of a higher share of this fish in the lake. The over-population may be one of the reasons for the constant size of Tilapia in the catch (dwarfing). There are reports that Tilapia affects the production of *P. curmuca* in the Meenkara reservoir. The presence of Tilapia is reported to be the reason for smaller size of *P. curmuca* in Malampuzha reservoir (Sugunan and Sinha, 1997). These experiences suggest that, to protect the native small fishes, intensive fishing of Tilapia using small gears is necessary. The obvious danger is that together with Tilapia

**Box 4.9 Yield of *O.mossambicus* in Relation to the Area of the Reservoir in Tamil Nadu**

Area of reservoirs	Contribution of Tilapia (kg/ha)	Percentage of the total yield (range)
Up to 50 ha.	101.50	32.3 – 50.6
50-100	82.4	13.2 – 21.97
100-200	43.8	0.50 – 87.3
200-500	19.4	0.06 – 53.5
500-1000	10.3	0.3 – 53.6
1000-5000	9.0	0.3 – 34.8
5000-10000	4.7	0.7 – 9.8
Above 10000	0.14	1.9
Total	7.8	0.14 – 21.9
PTR (2700 ha)	2.27	14.5 – 32.8

Source: Tamil Nadu Fisheries Department

similar-sized endemic fishes, especially *P.curmuca* will also be netted. As *P.curmuca* is abundant in the streams, as is the case with *Mahseer*, fishing intensity in the lake may not affect its sustainability.

The fish yield of the lake is considered partly a function of abiotic and biotic factors influencing productivity. Based on the productivity characteristics determined by physico-chemical parameters given by Jingran and Sugunan (1990), Periyar Lake may be categorised as medium productive. There are many methods available for estimating the potential and the sustained yield of fisheries in a lake; such a study requires intensive analysis of the various biological and chemical parameters. Unfortunately, no such studies exist for Periyar or similar ecosystems. So an accurate estimation of the potential and sustainable yield of Periyar Lake is difficult with the available information; rough estimates may, however, be suggested. Yield estimates may be based on Morpho Edaphic Index (MEI) widely accepted as one of the simple estimates of fish production in lakes and reservoirs (Ryder, 1982; Jenkins, 1982). The index is the ratio of the average total dissolved solids (TDS) in the lake water and the mean depth of the water body. Generally an increase in MEI shows an increase in fish production and yield (Obrion, 1990). That is, fish production is high when TDS is high and/or the mean depth is shallow (Rawson, 1952; Young and Heimbuch, 1982). Following the study of African Lakes by Henderson and Welcome (1974), Sugunan (1997) suggests that, on an approximation, half to twice their estimate can be used as the productivity of Indian lakes. Using the MEI figures given in Arun (1997), the fish yield potential of Periyar may be estimated as 84.15 to 336.6 tones (Box 4.10). That is 32.4 kg to 129.5 kg/ha. The present catch rate of 12.31 kg/ha is thus very much within the limits. The reservoirs, which are managed for commercial fisheries in Kerala show comparatively high yield per ha (53.50 kg/ha). Analysis on species-wise catches shows that only *C.carpio* has been exploited more than its yield, whereas *O.mossambicus*, *T.khudree*, and *P.curmuca* are exploited much within the productive potential. Considering the characteristics of exotic and endemic species and their interaction, the present trend of exploitation has to be sustained to keep the ecological harmony, though more intensive study is needed to confirm the present conclusions.

**Box 4.10 Comparison of Potential Yield Based on MEI and Present Fish Catch at PTR (1997-'98)**

Species	Potential Yield (Range kg)		Actual landing (kg)
	Minimum	Maximum	
<i>Tor khudree</i> *	5890	23561	9219
<i>Cyprinus carpio</i> *	3366	13464	15088
<i>Puntius curmuca</i> *	10098	40391	1161
<i>S.mossambicus</i> *	5890	23561	6129
Others*	58903	235613	414
Total	84148	336590	32011

\* Computed based on the proportions of experimental catch given in Arun (1997).

**Opinions of fishermen**

In order to understand the opinion of the tribesfolk engaged in the fishing activity, an interaction meeting between fishermen and forest department was organised under the auspices of the present project. The main issues discussed were the restrictions on fishing and the impact of fishing during the breeding season on the native species. The interesting aspect noted was that the fishermen, especially the younger generation, are fairly aware of the scientific aspects of different species. The general opinion about the breeding season of the fishes was the following: for *Puntius curmuca* – October-November; for *Tor khudree* – August-September; for *Cyprinus Carpio* – June, and for *O.mossambicus* – all seasons. These observations of the fishermen were proved correct in terms of our analysis. There are differences of opinion, however, among the fishermen on several other issues. Though some of the fishermen believe that restrictions imposed by the Forest Department are useful, some hold a different view. According to them, the ban on catching the *Mahseers* during the monsoon season is not needed. This is mainly because, there are abundant stocks of *Mahseers* in the streams and fishing in the lake no way affects the population of the *Mahseers*. They also argue that, because of the obstructions (the tree stumps) in the lake, massive fishing is not possible. Others feel that fishing in the breeding season would affect the stock especially for native species. All the groups share the opinion that there is competition between the native and the exotic species in the lake. In general the group was of the opinion that the presence of exotics is at present sustaining their life, as *C.carpio* and *O.mossambicus* dominate the catches. The absence of these species might lead to a fall in their income level and a higher exploitation rate of endemic species. They also feel that the choice of fishing as their vocation makes them depend on it perpetually, because, whenever they need money, they do not try for other jobs, but only venture further into fishing.

## 5. Institutional Aspects of Fishery

This section purports to identify the institutional arrangements in position and to examine their role in promoting fisheries in the study area. Three institutions viz., the State Fisheries Department, Kumili Tribal Fisheries Co-operative Society, and the State Forest Department are primarily associated with the development of fisheries in the area. The role of each of these institutions is briefly dealt with here.

### Fisheries department

In Kerala, Department of Fisheries has been actively engaged in the development of inland fisheries. The only reservoir fishery in Kerala exists in the Idukki district, in which the study area is situated. The district office of the Department, headed by an Assistant Director, is situated at Kumili, near the Labbakkandom tribal settlement. The general policy of the department is to develop fisheries in the inland water bodies through introduction and constant stocking of fishes. But in Periyar, the complete control of the lake being is vested with the Forest department and in the lake forming a part of the wildlife sanctuary, no developmental works of the Fisheries Department are allowed. So the present form of assistance to the promotion of fisheries by the Fisheries Department is limited to strengthening of institutional set-up and helping tribal fishermen. Assistance to fishery activities in the study area comes mainly from two plans: Tribal Sub-Plan (TSP) and Special Component Plan (SCP). These are statutory allocations for tribal development. Box 5.1 shows the total disbursements under different plan components during 1992-'93 to 1996-'97. The assistance is in the form of nets, feeds, houses, marketing assistance etc., to tribal fishermen, and financial assistance to Fisheries Societies.

#### Box 5.1 Financial Assistance to Fisheries in Idukki District by Fisheries Department (Rs.)

Year	Tribal sub Plan	Special Component plan	Total
1992-93	330,000	387,857	717,857
1993-94	359,171	766,075	1,125,246
1994-95	701,163	174,814	875,977
1995-96	546,041	445,400	991,441

Since no fishery activities exist in the study area, other than in the lake, the beneficiaries in the area consist entirely of the Kumili Fisheries Co-operative Society and the tribal fishermen associated with it. The assistance to the fishermen is given generally through the Co-operative Society. In PTR complete assistance to Society and fishermen comes from the TSP allotment. In 1996-'97 under this allotment, Rs One lakh worth of nets were distributed to 60 members of the Fisheries Society. Details of the funds disbursed in PTR are given in the Box 5.2. Since the allotment for fishery assistance to this area comes mainly from the tribal plans, no non-tribal beneficiaries received any assistance. A declining trend in the assistance given to the area may be noticed. This may be because, in the initial years, more funds were directed to providing building assistance to the Co-operative Society; this phase

is over. The department realised the need for strengthening the marketing set-up by removing the intermediaries. For this, the department provided support for the Co-operative Society in setting up marketing outlets, so that the fishermen could sell their catch directly to the Society, thereby avoiding exploitation by private traders. However, the inherent weakness of the co-operative set-up and the lack of its proper management led to the failure of this venture (Jayasankar, 1998). Since the policy of the Department is to strengthen the institutional set-up and thereby promote the welfare of fishermen, it continues to assist the Society in a number of ways. The society is also an intermediary for properly utilising the funds from the department. This purpose is often defeated because of the malfunctioning of the Society.

**Box 5.2 Financial Assistance to Fishermen and Society in PTR in Different Years**

Years	Amount (Rs.)
1992-'93	294216
1993-'94	249040
1994-'95	159030
1995-'96	109500
1996-'97	100000

***Forest department***

As the custodian of the Lake, Forest department controls the fishery activities in it. The Department granted exclusive fishing rights to *Mannans* considering the importance of fishery in the livelihood of the *Mannan* community. In order to control fishing activities and prohibit fishing by non-tribesfolk, identity cards were issued to the tribal fishermen. The Co-operative Society is entrusted with the task of co-ordinating these activities. In order to protect the endemic fish fauna, Forest Department enforces restrictions on fishing. Since the Forest department officials have good command over the tribesfolk, the latter seldom violate the restrictions imposed by the Department. Every year, before the onset of monsoons, forest department convenes a meeting of all the fishermen and briefs them about the steps taken. During this meeting, forest officials try to convince the tribal fishermen of the need for sustainable management of fisheries especially the conservation of endemic species like *Mahseers*. They enforce strict vigil especially against those catching Mahseers during the June-August season. During this period, fishermen are not allowed to fish in the up-stream areas where *Mahseer* is abundant. Sometimes the department also puts restrictions on the use of large mesh nets during this season. There are of course differences of opinion among the fishermen about the need for such restrictions.

***Kumili Tribal Fisheries Co-operative Society***

The Society started functioning in 1985 with 54 members with the purpose of organising the fishery activities in PTR. The present strength of the Society is 154. The second Director board is holding the administrative charge now. The Secretary and the Board of Directors belong to the *Mannan* community. The Secretary is one of the most educated persons in the colony. The infrastructure facilities of the society are good, and it functions in own building.

The main source of finance to the society is the Fisheries department. The Department has provided managerial grants and building grants. The salary of the office staff (especially the Secretary) is met from the managerial grant. A list of items for which assistance was given to the fishermen and the Society is given in the Box 5.3.

**Box 5.3 Nature of Assistance to Fishermen and Society in PTR in Different Years**

Year	Fishermen			Society	
	Amount	Nature of assistance	Amount	Nature of assistance	
1992-93	168,000	Nets to 75 families	126216	Building & Rent subsidy	
1993-94	212540	House to 2 families nets to 81 families	36500	Marketing assistance, Building & Rent subsidy	
1994-95	74750	Nets to 74 families	84280	Building & Rent subsidy	
1995-96	69500	Nets to 74 families	40000	Electrification	

A large number of schemes were launched by the Society with the help of Fisheries department; but none proved to be viable due to ineffective management of the Society. The Society started a fish collection store in the Kumili market with freezing facilities. It had to be closed down mainly because the price offered by the Society was lower than the price offered by private traders. Not only did private traders attract fishermen by offering them higher prices and advances; they also succeeded in persuading the management of the Society from taking any steps to correct the situation. At present the functions of the Society are limited only to those of an agent, transferring funds from government to the tribesfolk. Nor do the fishermen have any good opinion about the Society. At the time of the disbursal of funds, the Society convenes the meeting of the tribesfolk to identify the beneficiaries, a process which often ends in clashes between the management and the fishermen.

## 6. Socio-economic Analysis of Tribal Groups

The purpose of this section is to explore the socio-economic aspects of the two tribal groups in PTR for understanding their living conditions in relation to their occupation pattern.

### Family size and educational status

The tribal groups follow the nuclear family system. A typical family consists of father, mother, and one or two children. The average number of members in the family in the study area is only 3.64. The number of adults per family is 2.72. There is no marked variation between communities with regard to size of the family. Of the surveyed households 23.8 percent were female-headed (FHHs). For *Mannans* it is 26.2 percent and for *Paliyans*, 17.6 percent. The average age of the head of the household for the two communities together, is 45.3 years; it is higher for *Paliyans*, 49.5 years. The average age of the head of *Mannan* household is 44.8 years. Most of them (80 %) are illiterate or have only basic education. Forty-seven percent of the *Paliyans* and 36 percent of the *Mannans* have no formal education; 45 percent of *Mannans* and 30 percent of the *Paliyans* have primary level of education. The rest of the heads of households have high school level education. Illiteracy is rampant among the older generation. One *Balawadi* and a primary school are functioning well within the settlement. A pre-metric hostel for girls is also functioning here. These facilities have helped to raise the literacy level among the children.

#### Box 6.1 Family Composition of *Mannans* and *Paliyans*

	<i>Mannan</i>	<i>Paliyan</i>	All
No.of members	3.66	3.58	3.64
No. of adults	2.61	3.00	2.72
No. of male adults	1.26	1.52	1.33
No. of female adults	1.35	1.47	1.38

### Housing conditions

Housing conditions are fairly good for most of the households. The majority of the houses have tiled roofs and plastered brick walls. A few houses have asbestos sheet for roof. Most of the houses were built after the visit of the Prime Minister late Sri Rajeev Gandhi. Tribal Development department and Fisheries department have also built houses for these groups. Till 1996-'97, assistance was received for construction of house buildings for households in Labbakkandam under the tribal sub-plan allotment by Fisheries department.

#### Box 6.2 General Housing Conditions of *Mannans* and *Paliyans*

	<i>Mannans</i>	<i>Paliyans</i>	All
Traditional	19.0%	0.0%	13.6%
Tiled	66.7%	88.2%	72.9%
Sheet	11.9%	11.8%	11.9%
Others	2.4%	0.0%	1.7%



Nearly 32 percent of the households have electricity connection (29 percent of *Mannans* and 40 percent of *Paliyans*). All have access to drinking water. The sources are wells, streams, and tap. Twenty-nine percent of *Mannans* and 15 percent of *Paliyans* have own well. Others depend on nearby streams. Though municipal tap water facilities are available, the supply is very erratic and scanty.

### Box 6.3 Accessibility to Various Facilities for Labbakkandom Settlements

Primary School	+
High School	+ +
Anganawadi	+
Hospital	+
Market	+ +
Forest Office	+ + +
Post Office	+ +
Police Station	+ +
Ration Shop	+ +
Bank	+ +
Hotel/Teashop	+ +
Cinema Theatre	+ +
Bus station	+ +

- + Within the settlement
- ++ Within 1 km from
- +++ settlement
- +++ Between 1 to 3 kms

### Occupation

The details on the nature and pattern of primary employment of the tribal groups were explained in Section 3. The secondary employment pattern of these groups is explored here. Many of the firewood collectors (50 percent) engage in casual labour as the second option. The rest engage in agriculture (12.5 percent), fishing (12.5 percent), and other household works (12.5 percent). A few (12.5 percent) remain unemployed. For the fishermen, the secondary occupation is mainly agriculture (58.8 percent), followed by casual labour (23.5 percent), NTFP collection (11.8 percent), and tourist guidance (5.6 percent); of the casual labourers, 36.6 percent do agricultural activities when they are unemployed; 27.3 percent go for firewood collection and 18.2 percent engage themselves in fishing. The farmers remain in general, idle; a few go for firewood collection or perform other household activities in their spare time. Most of the NTFP collectors remain idle during their off time. Fishing is not a secondary option (which is always a primary source) for this tribal group. Firewood collection, casual labour, and agriculture are the main secondary options for most of the households in the study area.

### Land holding

Forest department has given land for cultivation for the *Mannan* and the *Paliyan* households. The total land area owned by each household varies between 0.02 ha and 2.85 ha. No title

deeds were given for the allotted land, by the Forest department. The main crops raised here include pepper, coffee, cardamom, rice and annuals like plantain, and tuber crops. The land is highly fertile and suitable for pepper and coffee cultivation. The average land holding size of both the communities together is 0.58 ha. For *Mannans* it is 0.60 ha and for *Paliyans* it is 0.55 ha. The major portion of the land (nearly 70 percent) is devoted to the cultivation of pepper. The next important crop is coffee followed by cardamom and rice. The practice of leasing is very common in the settlement. Since most of the crops are perennial in nature, land leasing is rare and limited to paddy fields. In case of other crops, trees/plants are mortgaged. For example, the leaseholder has the right to harvest the produce of pepper or coffee for one year or a few years depending on the contract. In return he advances funds to the owners. Generally the lease amount varies between Rs 5,000 to Rs 10,000 per acre of pepper. This amount constitutes only about 70-80 percent of the market value of the product. It is the duty of the owner to maintain the crop. The leaseholder may also employ the owner for harvesting the produce. This forms an income source for the tribesfolk. In December-January season most of the tribes engage in the collection of pepper in own land and/or in others' land. The leasing always ends in a vicious circle, the tribesfolk never becoming able to come out of the lease trap. The leaseholders are always ready to advance money for the tribesfolk in times of emergency such as medical treatment or for buying food. Since the tribes never get the real market value of their agricultural produce, they cannot make any money savings and depend again and again on the intermediaries for funds.

**Box 6.4 Land Holding Pattern of *Mannans* and *Paliyans* (ha.)**

Crops	<i>Mannans</i>	<i>Paliyans</i>	All
Pepper	0.42	0.40	0.41
Coffee	0.22	0.13	0.20
Cardamom	0.10	0.19	0.16
Paddy	0.07	0.00	0.06
Others	0.07	0.04	0.06
Total	0.60	0.55	0.58

Note: The total may not equal to individual sum because, same land is used for raising

**Income**

There exist many income sources for the *Mannans* and the *Paliyans*. Sale proceeds of fishes, agricultural produce and firewood and earnings from casual labour are the more important among them. From Box 6.5, it may be seen that agriculture provides the major source of income for both the communities (45 percent and 38 percent for *Mannans* and *Paliyans* respectively). Consistent with the results of the analysis in the earlier sections, we find that firewood collection and casual labour are the important sources of income for *Paliyans* whereas fishing and casual labour are the major sources for the *Mannans*. Fishing is relatively unimportant for *Paliyans* in the same way as firewood collection is for *Mannans*. The total family income is much higher for *Paliyans* of which a major share is contributed by non-agricultural sources. The share of non-agricultural income of *Mannans* is nearly half that of *Paliyans*. In terms of total family income, both communities are above the poverty line. Per capita income is also higher than the State average.

**Box 6.5 Average Annual Family Income from Different Sources (Rs.)**

	<i>Mannans</i>	<i>Paliyans</i>	All
Fishing	5635	929	3794
Firewood collection	507	10140	3282
Casual labour	4952	6643	5439
NTFP collection	677	1579	937
Forest department works	823	574	751
Others	628	524	598
<i>Total Non-agriculture income</i>	<i>13222</i>	<i>20913</i>	<i>14801</i>
Agriculture	11131	12916	11633
Total	24353	33829	26434

The composition of agricultural income is shown in the Box 6.6. It is interesting to note that though *Mannans* possess (marginally) higher land area, their average agricultural income is lower than that of *Paliyans*. There are two reasons for the difference: (i) As most of the *Mannans* are fishermen, the individual attention given by them for managing the land is very low; and particularly so because most of the time they live in the forests. They engage in agricultural activities only in times of urgency. (ii) The dependence of *Mannans* on moneylenders is high; and they seldom get the right price for their produce. The *Paliyans*' dependence on moneylenders is, on the other hand, is comparatively low.

**Box 6.6 Pattern of Agriculture Income of *Mannans* and *Paliyans* (Rs)**

	<i>Mannans</i>	<i>Paliyans</i>	All
Pepper	9720	10322	9899
Coffee	561	533	554
Cardamom	131	1559	542
Paddy	175	114	158
Others	544	388	485
Total	11131	12916	11633

***Saving and asset holding***

Though the family income of *Mannans* and *Paliyans* are relatively high, only a very low proportion of their households have the habit of saving. Only 11 percent of the households of *Mannans* and 17 percent of households of *Paliyans* have savings. The average amount of savings per saving household is also very low Rs 575. The maximum savings of a household in the study area was found to be Rs 5500. The main form of saving is an outstanding credit balance kept with the moneylenders (after adjustments) after the sale of agricultural produce. A few hold bank accounts. Almost 95 percent of the households own the ration card. Only 25 percent of the households (21 percent *Mannans* and 35 percent of *Paliyans*) possess some kind of movable household assets. The assets include jewellery, radio, TV, and Tape recorders. Five percent of *Mannans* and 11 percent *Paliyans* possess TV sets, 69 percent of *Mannans*

and 64 percent of *Paliyans* possess Radio and 5 percent of the *Mannans* and 10 percent *Paliyans* possess tape recorders. Nearly 52 percent of the *Mannan* and 47 percent of *Paliyan* households have either gold or silver jewellery. The average value of assets per household is about Rs 2,120; Rs 1950 for *Mannans* and Rs 2,496 for *Paliyans*.

Fifty-nine percent of the *Paliyans* and 80 percent of the *Mannans* have one or another form of debt. Indebtedness is mainly to grocery shops and to moneylenders. The average amount of debt is Rs 1000 with the maximum going up to Rs 9,700. Usually all the debts are cleared during the pepper-harvesting season.

### ***Expenditure pattern***

There is no marked difference in the expenditure pattern as between the communities. The major item of expenditure is food. Education, entertainment, and miscellaneous items account for only a small share. More than 10 percent of the expenditure goes for consumption of alcohol and for pan chewing. In absolute terms the expenditure on these two items ranges between Rs 300 to Rs 2700 per month, which comes to 5 to 30 percent of family income. Clothing is also one of the important components of the expenditure items. Medical treatment expenses account for nearly 13 percent. Households are prone to various types of infectious diseases because of their stay inside the forests. Though a government dispensary exists near the settlement, most often the inhabitants go to nearby private hospitals for reliable and prompt treatment.

### **Box 6.7 Household Expenditure Pattern of *Mannans* and *Paliyans* (%)**

	<i>Mannans</i>	<i>Paliyans</i>	All
Food	54.0	55.0	54.4
Clothing	8.4	10.8	9.1
Education	3.8	3.4	3.7
Entertainment	3.6	8.2	4.9
Chewing beverages	12.5	10.6	12.0
Health	14.6	8.4	12.8
Miscellaneous Travel, Customs etc.	3.1	3.6	3.1
Total	100.0	100.0	100.0

### **Awareness level and opinion of households**

Together with the survey on the socio-economic aspects, we attempted to understand the awareness level of the tribal households on biodiversity conservation and forest protection. The results are presented below.

#### ***Institutions: Fisheries***

Sixty-eight percent of the households are members of either the Fisheries Co-operative

Society or the Minor Forest Products (or NTFP) Co-operative Society. At present, the MFP society is defunct and the fisheries society is functioning only partially. The households have differences of opinion on the way the fisheries co-operative society is functioning. All the sample households opined that presence of an efficient society is essential for ensuring them fair returns for their products by reducing the exploitation of private traders. Forty-seven percent said the society is functioning, but only nominally; of this 27 percent had the opinion that the present way of functioning is far from satisfactory. But the rest 53 percent said that they receive no benefits from the society. They also pointed out that the reason for the present condition of the society is corruption among the officials.

About 24 percent of the households received assistance from the Fisheries department and 5 percent from the Tribal Welfare Department. The assistance is mainly in the form of fishing aids like nets. The rest haven't received assistance from any agency. About the restrictions imposed by the forest department on fishing, 75 percent opined there exists only partial restrictions. They also support the view that restrictions are needed during the breeding season. Nearly 65 percent felt that the present policy of issuing licenses has to be continued for preventing 'illegal' fishing in the lake. About one-fifth of them were of the opinion that licences are not needed because the area is well protected and entry of outsiders other than tribesfolk is difficult. Forty-five percent of the households<sup>17</sup> know that there are endemic and threatened species of fishes in the lake. Some of the households mentioned that fishes like *varals*, which were abundant earlier, are no more found in the lake. They also know that *Mahseers* and *Puntius* species are endemic species, which are to be conserved. All the households expressed the view that a ban on fishing is not at all needed to conserve the endemic and threatened species. According to them a complete ban will not only increase the proportion of exotic species but result in the starvation of those depending on fisheries as well. About an equal proportion said that complete ban on fisheries would make no difference, as they would continue to do fishing illegally, and that they do not like to go for other jobs. Nearly 30 percent would shift their occupation from fishing to firewood collection and casual labour. The rest have no opinion on the question on banning fishing in the lake.

### ***General issues***

About 19 percent of the *Mannans* and 29 percent of the *Paliyans* reported that they do not know whether a wildlife sanctuary exists in PTR or not. On the question of what a wild life sanctuary is, nearly 24 percent of households (21 percent *Mannans* and 29 percent of *Paliyans*) had no idea though they were living within the sanctuary itself. About 60 percent had a vague idea of a wild life sanctuary. But 17 percent (19 percent *Mannans* and 12 percent *Paliyans*) clearly spelt out what a wildlife sanctuary is and the reasons for establishing it. All these respondents also know that tiger is the main animal protected in the Periyar sanctuary. About one-eighth of *Paliyans* and 14 percent of *Mannans* thought that the sanctuary was established about 20 years ago. But most of them (nearly 80 percent) admitted that they have no idea about the year of its establishment. A few (2 percent) reported that the PTR was established less than five years ago.

About 61 percent of the households reported that they have no opinion on or knowledge of the reasons for protecting animals or plants or conserving biodiversity. About 27 percent agreed to the reasons for protection of biodiversity and establishment of sanctuaries and national parks like PTR; 18 percent were indifferent; 17 percent also were of the opinion that creation of sanctuary had costs too in the form of damage to crops and humans by animals, for which no compensation was being given by the Forest department. But the majority disagreed. According to them the life pattern of tribal households is linked to forests and attacks by the animals is part and parcel of their life.

The forest officials claim that they have good contact with all the households in the area; however only 12 percent of the sample households know the name of the forest officer in the area; 42 percent found difficult to remember the name of the officials though they know them in person. The rest have no idea about the officials of the Forest department. Nearly one-third of the households said they have no contact with the forest officials in the area; 35 percent have good contact with the forest staff as they worked/work for the Forest department. Most of the households are of the view that the Forest department officials are lenient towards their demands and are helpful during times of difficulty.

Opinions were also gathered about the Eco-development programme<sup>18</sup>, which is being implemented with the aid from World Bank aiming at participatory forest management for conservation of biodiversity. The long-term objective of the project is to provide assistance for generating alternative employment opportunities for forest-dependant communities to reduce their dependance on forest, thereby conserving forest resources. The project is popularly known as “Eco” among the households. Most of the households have little idea about the aims of the project. They only know that, under the project, the Forest department provides money to them, which is not necessarily repaid. Some (33 percent) feel that it will improve the condition of the tribesfolk as the project tries to provide them with other sources of employment.

An interesting opinion expressed by at least 35 percent of the households during the discussion was that the proximity and dependance on the income sources such as fishing, NTFP and firewood collection is the main reason for the tribal groups remaining underdeveloped. Since these options are readily available whenever required, they seldom try to find out better employment opportunities outside the forest.

The foregoing analysis has shown that the tribal groups in general are better off in terms of socio-economic parameters except educational level. The housing conditions are fair to moderate and average family income is above the poverty level. Agriculture, especially pepper cultivation, contributes 30-50 percent of the income, though they realise only 10-20 percent of the value of the products due to exploitation of moneylenders. They have the habit of spending more than they earn. The savings and asset holdings are very low, and a good share of income is spent on pan-chewing and alcoholic beverages. The communities are aware of the importance of biodiversity conservation. Their knowledge level on the fishery resources is also good.

## 7. Analysis of Options

In the earlier sections, the nature of dependence of the tribal communities on forest and lake resources was examined. The analyses have shown that the tribal communities are basically forest-dependant though the nature of the resource dependence varies with communities. The *Mannan* community depends mainly heavily on the fishery resources in the lake and the *Paliyan* community depends on firewood collection. Both have their impact on the regional biodiversity. In this section, different alternatives are explored and their implications on biodiversity conservation and livelihood of tribal groups analysed. Though the alternatives presented are complementary to one another, for the sake of simplicity, the analysis is carried out in terms of the impact of the specific options under analysis. Since the aim of the present study is to explore the exclusive issues relating to fishery activities in the lake, the scope of the present section is limited to this aspect only.

### Option 1: A complete ban on fishery activities

The presence of endemic / threatened fishes in the lake would warrant, prima facie, a complete ban of all fishery activities in the lake. Statutorily too this argument stands as, in a protected area with status of the Tiger reserve, no resource exploitation is to be allowed. But the issue is not as simple as to yield easy solutions. At least two problems arise: One, the presence of exotic species in the lake; Two, livelihood of the dependant *Mannan* community. The presence of these two aspects eliminates the possibility of a complete ban on fisheries. As shown in the earlier section, the presence of *Oreochromis mossambicus* and *Cyprinus Carpio* causes higher diet overlaps with endemic and threatened fish species in the lake. Especially *C. carpio* shows higher diet overlaps with commercially exploited *Tor khudree* and *Puntius curmuca*. Because of the resource competition, the pressure on endemic species is high. At present this pressure is kept at a low level mainly because of the fishery, as the exotic species dominate the commercial catch. A complete ban on fishery would mean allowing the exotic species to breed freely; a situation which might lead to severe resource competition between the native and the exotic species. As a result, the exotics might deplete the stock of the indigenous species since the former is inherently more powerful and are more prolific breeders. Thus the effect of unchecked growth caused by non-exploitation of fishes creates eventual loss of these species in the lake. So on ecological reasons, and for the presence of the exotic species in the lake, complete ban on fisheries in the lake is ruled out.

In the case of the livelihood issue too, a ban on fishery would create problems. Nearly 40 percent of the *Mannans* primarily depend on this resource. For *Paliyans* also it is a significant source. It forms an income source when other jobs are not available. A complete ban on fishery affects their existence, as shifting to other occupation is not easy. The tribal households are adapted to their occupational pattern over a period of several centuries. Only very few of them have expressed their willingness to shift from fishing in case there comes a complete ban. New employment opportunities existing in the area such as tourism-related work is alien to the tribal households (except for some tribal youth self-employed as tourist guides). Lack of educational qualifications and lack of exposure to other fields of activity are the major reasons. The local non-tribal population easily grabs these opportunities.

## **Option 2: Partial / seasonal restrictions**

A practical approach to protecting fish biodiversity is allowing fishing in a controlled way. There are many alternatives available such as seasonal fishing restrictions, area demarcation, and restrictions on the use of fishing gears. The pros and cons of these alternatives in relation to the livelihood of *Mannans* may be examined.

Observing a closure period during the breeding season of the endemic species will help develop the stock of these species. But there are other issues. The breeding seasons are different for different species; for example, for *P. curmuca*, there are three peak seasons in a year (March, July and November), whereas for *T. khudree* the season is in October-November. Observance of a closure period for nearly six months in a year in the lake would affect the *Mannan* community badly. Not only that, the catch pattern shows that the highest catch coincides with the breeding season. Since the market price of the fish is constant, the higher catch has a direct impact on the income. So a ban on fishing during this season would reduce the income of the fishermen. Thus the option of observing a closure period during the breeding season of fishes in the lake is not viable unless alternative employment options are made available to the *Mannan* fishermen. An alternative is limiting the fishing area. As *T.khudree* and *P.curmuca* are abundant in streams, even a complete ban on fishing in these areas will be highly useful. Since the fishing in the lake is not limited, the income of the dependant fishermen may not be affected much by this measure.

There is also an option of reducing the number of fishermen. But at present on an average, 16.1 persons sell fishes at the landing per day<sup>19</sup>. For the lake having an area of 26 sq. km, the present density of fishing units is low. The pattern of the use of fishing gears also directly affects the stock. At present fishermen use only passive gill nets. The presence of obstructions (such as withered tree stumps) in the lake restricts the use of other active gears. The size of the fishes arriving at the landing is small, except in the June-August season. This is because of the use pattern of fishing gears. At present fishermen use gill nets of three sizes (Box 4.1). The big nets are used intensively during the rainy season (July to September) and smaller nets are used throughout and intensively in the summer periods. The intensive use of smaller mesh sized nets has the disadvantage of harvesting the smaller fishes without even allowing them to grow or breed. This practice may affect the stock of the species. But intensive use of smaller gears has the benefit of sparing the larger fishes, which have the capacity to breed. The pattern of catch, the breeding season and the use of gears show that the exotic species *C.carpio* dominates in the catch during the July season, which coincides with the breeding season of *C.carpio* and the period of use of the larger meshes. Catching large and grown up *C. Carpio* has the possibility of limiting the expansion of the stock of this species. The other exotic species, *O.mossambicus*, which is a prolific breeder, dominates the catch during the seasons during which smaller gears are used intensively. As noted earlier, even with this practice, the share of exotic species is increasing in the stock<sup>20</sup>. In these circumstances, a judicious mix of gears is necessary in fishing in the lake.

## **Option 3: Increasing the price of fishes**

Periyar fishes are sold locally. The prevailing market prices ranging between Rs 35 and Rs



60 per kg are higher than those of marine fishes available in the market. The prices of Periyar fishes are high because the demand for these varieties is high. The fishermen receive about 75 percent of the market price, and the trader receives the rest. Increase in the prices of the fishes increases the income of the fishermen. A 10 percent increase in the prices received by the fishermen will at present increase the average income of the community by only 1.2 percent<sup>21</sup>. But this possibility is remote as the prices of Periyar fishes are already higher than those of marine fishes available in the market; a further rise in prices may lead to reduction in demand. If market prices do not increase corresponding to increase in the farm prices, the traders would receive a lower margin. For instance, an increase of 10 percent in the prices received by the fishermen would reduce the margin of the trader by 6 to 8 percent if the market prices remain unchanged. Since only few private traders dominate the market, this possibility is also remote. Another danger of increasing the prices would be that it might act as an incentive for accelerated exploitation of fish resources.

#### **Option 4: Increasing income from agriculture**

Increasing income from other employment opportunities is one option to reduce dependence on fishery, thereby helping conservation of the fish diversity. The communities taken together, about 44 percent of their income is derived from agriculture. Income from pepper alone accounts 85 percent of the farm income. The average production is 933.44 kg of pepper per household fetching them an average income of Rs 9899, which works out to Rs 10.60 per kg. The market price is about Rs 39 for green pepper. The low realisation of value is due to leasing. If they were they able to sell the product at market prices, their average household income would have increased to Rs 36405, showing an increase of Rs 26506, increasing the income from agriculture alone by more than 200 percent.

#### **Box 7.1 Expected Change in Household Income from Change in Price of Pepper**

	<i>Mannans</i>	<i>Paliyans</i>	<b>All</b>
Land Owned (ha.)	0.60	0.55	0.58
Pepper Area (ha.)	0.42	0.40	0.42
Pepper production (kg)	948.71	895.75	933.45
Average Income realised (Rs.)	9720.00	10341.00	9899.00
Total Agriculture income	11131	12916	11633
Average Price realised (Rs./kg)	10.25	11.54	10.60
Average Farm Price (Rs./kg)	39.00	39.00	39.00
Income at Average Farm Price (Rs.)	36999.00	34933.00	36405.00
Change in Income (Rs.)	27279.00	24592.00	26506.00
Change in Income from Agriculture (%)	345%	290%	328%

#### **Option 5: Exploring other income opportunities**

The present employment pattern is highly dependant on forest use. The degree of dependence on forests and the aquatic resources by the community could be reduced drastically only if other employment opportunities are available. There are alternatives available in the area,

which could be explored to restrict dependence on forests and aquatic resources. Tourism in the area is one such source with high potential. There are tribal youths even at present employed as tourist guides, with the help of Forest department. The hotel industry is also fast developing in the area. A major limiting factor in this direction is the lack of necessary skills for the tribesfolk. The Forest department is now implementing the India Eco-Development Programme<sup>22</sup> to conserve the biodiversity of the area with the help and participation of the local people. Under this project various schemes are envisaged to enhance the skills and thereby the employment opportunities of the local people. The assistance given under this project includes the following:

- (i) Technical and financial assistance for improving agriculture;
- (ii) Fishing rights for permanent fishermen;
- (iii) Training programme for tribal youths as tourist guides; and
- (iv) Micro-planning and feasibility analysis on creation of self-employment opportunities and creation of viable small scale units.

This year, the project plans to market all the pepper harvested by the tribal households by entering into contract with a co-operative marketing agency. Compensation will be paid for those who have advanced funds and taken pepper vines on lease from the households. This step would ensure the tribal households reasonable price for their produce.

#### **Option 6: Strengthening institutional machinery**

The Eco-development Programme and its experience in marketing of pepper amply prove the necessity for and usefulness of strong institutional mechanisms. The activities of the Eco-development programme, which had been started with co-operation from several agencies and the tribesfolk, have started yielding fruits. The influence of strong intermediaries and moneylenders, however, continues in the marketing of agricultural produce and fishes. Their perpetual indebtedness forces the tribesfolk to depend on the moneylenders. A strong centralised marketing set-up is necessary to free them from the clutches of the moneylenders and to ensure them fair remuneration. Good prices for the agricultural produce themselves are enough to reduce the extent of their dependence on forest resources. A co-operative marketing set-up under a strong agency like Forest Department (under Eco-development) may solve this problem. The marketing agency should also be able to meet the immediate cash needs of the tribesfolk; such advances could be recouped from them while purchasing their products. Such a measure would also set limits to the activities of the moneylenders. But a mere presence of the co-operative set-up does not ensure benefits, as exemplified by the experience of the Fisheries Co-operative Society.

The Fisheries Co-operative Society does not function well mainly because of pressures from private fish traders. Two years ago, a centralised fish collection and marketing mechanism was attempted by the Society, with adequate infrastructure such as a shop and freezers. The attempt failed because the prices offered by the society were lower by Rs 2 per kg than those offered by private traders. Private traders offered not only higher prices but also gave advances to the fishermen. Thus the retaliation from the organised private traders led to the eventual closedown of this mechanism. No attempt was made since then to correct

the situation and to rectify the marketing processes. The society has been reduced to the status of a route for distribution of funds from the Fisheries department.

The foregoing analysis has shown that some of the alternatives such as the option 1 are not strictly alternatives as these are not viable considering the impact on biodiversity as well as on livelihood of the tribesfolk. It is true that most the options presented have to be implemented together to minimise the conflicts in the area. The policy implications of the options are analysed in the next section.

## 8. Conclusions and Policy Implications

### Summary and conclusions

Conservation of biological diversity has become an important issue for most of the governments especially in the Third World. The massive increase in population and the resultant encroachment into the forest areas have put increasing pressure on biodiversity. Establishment of Protected Areas has become one of the ways to counter this threat. The conception of Protected Areas creates, however, a situation in which the traditional rights of the dependant local population are curtailed. Under the recent philosophy of participatory management, authorities allow exclusive right of access to communities traditionally dependant on these resources. In most cases, this policy creates conflicts between conservation objectives and the livelihood objective of dependant communities. Such a situation exists in the Periyar Tiger Reserve in Kerala, where the endemic and threatened fishes are exploited commercially by the traditional tribal groups. One of the primary occupations of these groups is fishing. The issue becomes complex due to the presence of exotic fish species in the lake.

The Periyar Tiger Reserve, one of the biodiversity hotspots in the Western Ghats, which calls for high priority conservation status. The uniqueness of the Reserve is the 26 sq. km lake formed by the construction of Mullaperiyar Dam nearly 100 years ago. The reserve holds nearly 5000 flowering plants of which 2100 are endemic to the Western Ghats. The Reserve is also rich with large numbers of mammals, birds, reptiles, amphibians, and invertebrates. The aquatic ecosystem is also unique having 27 species of fishes of which 14 are endemic and 9 are endemic and threatened. Two exotic species were introduced in the system in the early 1970s. A recent study provides conclusive evidence on the disappearance of eight highly endemic fish species from the lake and streams. The disappearance is alarming considering the short time span of 30 years since the introduction of the exotic species. Commercial fishing practised in the lake by the Tribal group of *Mannans* increases the danger potential. The present study explores this conflict in the light of conservation objectives and livelihood opportunities of tribal groups.

The analysis of livelihood activities of two tribal groups, viz., *Mannans* and *Paliyans* in the area, reveals that, by and large, the *Mannans* depend on fishing and the *Paliyans* depend on firewood collection. Five primary occupational categories are identified such as fishermen, firewood collectors, agriculturists, NTFP collectors, and casual labourers. Most of the households have highly productive land, and the major crops are pepper, cardamom, and coffee. Due to factors such as accessibility and socio-cultural situations, the level of dependence of these tribesfolk on forests is high. Though potential alternative income and employment opportunities are available, these groups seldom switch away from their traditional occupational patterns.

The fish landing data collected for a period of one-year shows that two categories of exotic species dominate the catch. Thus the contribution of exotic species to the income of fishermen is high (about 67 percent of income from fishing). On the other hand it also points out the ecological danger of invasion of exotic species on the endemic species. This very fact rules

out the possibility of a complete ban on fishery activities in the lake to protect the endemic species. The continuance of fishery at the present level is necessary to restrict the stock of exotic species. Bamboo rafts and ordinary gillnets with varying mesh sizes are at present used for fishing. The presence of physical obstruction in the lake restricts the use of active fishing gears and crafts. Hook and line is also common.

The fishes from Periyar are sold locally. The demand for Periyar fishes is very high in the locality, both for household consumption and for use in restaurants. The market price of Periyar fishes is higher than that of marine fishes. The higher price does not lead to higher fishing activity for two reasons: (i) the presence of physical obstructions prevents greater active fishing; (ii) increase in output from the lake is possible only by increasing the number of operating units. As the fishing rights are granted only to the *Mannans*, increasing the number of units is not possible in the short run. Secondly, strict monitoring by the Forest department acts as a hindrance to further commercialisation of fishery.

The pattern of fishing activities revealed that the peak season coincides with the monsoon and the breeding season of the commercially harvested species such as *C. carpio*, *O. mossambicus*, *T. khudree*, and *P. curmuca*. This coincidence has led to harvesting of large numbers of female mature fishes, which are on the verge of spawning, thereby affecting their stock. At present the Forest department restricts fishing in the upstream for three months starting from June, mainly to protect the breeding of *T. khudree*. This measure is useful only for the specific species, which breed during this season. It is also true that *T. khudree* is abundant in the streams and that a closure period during the breeding season of *T. khudree* is highly helpful for sustaining its stock. The observation from the present study shows that the peak-breeding season of *T. khudree* is in November<sup>23</sup> and that the peak catch season is in October. This shows that the present restriction has no effect on the breeding of *T. khudree*.

Fish marketing is dominated by private traders. The average marketing margin is about 25 percent of the final price. The traders provide advances to the fishermen. The establishment of the tribal Co-operative Fisheries Society in 1985 to promote the fishery and to free the fishermen from the clutches of middlemen has not fully succeeded in its objectives because of the strong influence of private traders in the day-to-day functioning of the society. The centralised Fish Collection and Sales depot opened by the Society was closed down under pressure from private traders. Though the society has good infrastructure facilities, it functions only nominally. The functions of the society are limited to disbursement of benefits from different agencies, particularly the government.

All the households in the settlement own productive agricultural land. Commercial crops are raised in them. Since land leasing is common, the lessees and moneylenders reap the actual benefits. Here also, the establishment of an efficient marketing system assumes crucial importance. At present the households receive only one-fourth of the market value of their products. The Eco-development Programme practising participatory forest management with local participation has ventured now to free the households from the grip of moneylenders.

## Policy recommendations

The foregoing discussion suggests that because of the inherent characteristics of the system, there exists a trade off between conservation of the aquatic ecosystem and the livelihood of tribal households. In order to enhance the quality of conservation of the existing fish biodiversity and to improve the living standards of the dependant communities, the following recommendations are made.

- (i) Owing to the dependence of *Mannans* on fisheries and the presence of exotic species, a complete ban of fishing activities is not only unviable but detrimental to the endemic fish species as well. Even if complete ban is imposed, those who depend on fishery might continue to remain so. The present density of fishing (8 to 23 trips per day<sup>24</sup>) is negligible considering the large size of the lake. The practical way of limiting the ill effects of fishery would be, therefore, to impose partial restrictions. The commercially exploited endemic fishes are abundant in the upstream. In order to support and strengthen the stock in the lake, a complete ban on fishing in the upstreams is to be imposed. Since the exotic species such as *C.carpio* and *O.mossambicus* are not present in the upstreams, the stock of endemic species would not face any threat of extinction.
- (ii) At present large sized fishnets are used only during the monsoons; small nets are used throughout the year. There are merits and demerits of intensive use of these nets. The drawback of using large nets is that only big fishes such as *T.khudree* and *C.carpio* can be collected and that small exotic species such as *O.mossambicus* are spared. Intensive use of small nets though efficient in catching *O.mossambicus*, does not spare small-sized endemic species *P.curmuca*. The intensive use of small nets also affects the stock of all species. Therefore simultaneous use of different types of nets is needed to exploit all categories of fishes from the lake. More studies on the impact of using different fishing gears need to be conducted. The possibility of ranching of commercially-exploited species should also be explored.
- (iii) There is no dearth of institutions in the area. But what is needed is the efficient functioning of these institutions. Lack of commitment, corruption, and lack of management skills are some of the more important reasons for the malfunctioning of these institutions. Strong functioning of the Society would help increase the incomes of the fishermen. Centralised collection and marketing under the Society would reduce the influence of private traders.
- (iv) At present on an average 45 percent of family incomes is derived from agriculture. If tribal households are freed from the clutches of moneylenders, the share of agriculture could be increased substantially. An agricultural marketing society has to be setup to market the agricultural produce of the tribal households. The Society should be equipped to provide financial and technical assistance to the households.
- (v) The educational status of the tribesfolk is very low despite the fact that their income level is relatively high. Steps are to be taken to enhance the educational level of the

tribal households. The younger generation should be given training in relevant areas to gain from the available employment opportunities associated with the tourism industry.

- (vi) The present activities of the Eco-Development Programme for achieving the objective of biodiversity conservation are commendable. The Programme should be given due consideration and active assistance by all government departments associated with the Programme.

## End Notes

- <sup>1</sup> It is worth mentioning here the decision of the Supreme Court to ratify the action of the Madhya Pradesh Government of giving licences to 305 tribesfolk formerly residing within the Pench National Park for fishing in the Totladoh Reservoir situated in the Reserve (*The Hindu*, 1997).
- <sup>2</sup> A threatened species is one which is thought to be at significant risk of extinction in the foreseeable future, because of stochastic or deterministic factors affecting its population or by virtue of inherent rarity. IUCN maintains and updates the database (Red Data Book) of species at risk according to the severity of threats facing them and the estimated imminence of their extinction (World Conservation Monitoring Centre, 1992).
- <sup>3</sup> Initially 30 households were selected for the purpose. But after three months one household from *Paliyan* community migrated to Kozhimala, reducing the sample size to 29. As the study was completed in three months, no attempt was made to substitute the migrated household.
- <sup>4</sup> While selecting the households for a year-round monitoring, weightage was given for the *Mannans* since the prime objective of the present study was to understand the conflicts in the fishery activities in the area. Further, in the sample area, the number of households of *Mannans* is higher than those of *Paliyans*.
- <sup>5</sup> Since most of the time more than one occupation overlap, approximation has to be made on the number of days employed in each occupation, based on the response from the sample households.
- <sup>6</sup> GSI is ratio of weight of gonad to weight of the fish expressed in percentage. This index is used in general to determine the breeding season of fishes. As the breeding season approaches GSI increases as the eggs grow and the weight of gonad increases in relation to body weight.
- <sup>7</sup> Unemployment here denotes either the free time or leisure or the period with no employment. When they do not have any job, they have the option of choosing between leisure and going for NTFP / firewood collection or fishing, the choice depending on the attitude of the household concerned. Here free time may be treated as leisure, as the household has opted to remain idle/unemployed though other options are available to him.
- <sup>8</sup> Days of household activities of women include their leisure/unemployed days.
- <sup>9</sup> The study by Central Institute of Fisheries Technology revealed that, yellow-, and orange-coloured nets yield better catch than blue- or dark-coloured nets (Nayar, 1979).



<sup>10</sup> Local name

<sup>11</sup> The local names of this fish are *Mahseers*, *Mahasaula*, and Tora. Probably these names have reference to the large size of the scales or the head. The fish is distinguished generally by the length of the head, the head being as long as the depth of the body (Singh and Menon, 1994).

<sup>12</sup> The steep increase in the catch figures in the span of two years seems astonishing. This may be due to the underestimation of the figures given by Arun (1997). The estimate by Arun (1997) is based on the catch collection data from the Kumili Fisheries Co-operative Society, which was actively engaged during 1995-'96. All the fishermen are supposed to sell their products at the Society during that period. Since the price offered by the society is lower than that offered by private traders, there is high probability of bypassing the society by the fishermen. Thus the figures available with the society might underestimate the actual catch, as they would not include the trade through private traders. At present the trade is controlled completely by private traders and the society is not actively engaged in fish collection, though it is still the main link between the tribal fishermen and the Fisheries department (The institutional aspects are analysed in detail in the later sections).

<sup>13</sup> Similar observations on *Mahseers* were reported elsewhere (Pathani, 1994, Kulkarni and Ogale, 1994).

<sup>14</sup> Same observation on other species were reported elsewhere (Parameswaran et al, 1970; Sivakami, 1982).

<sup>15</sup> It is true that the lower catch rates sometimes imply a low population, an implication that contradicts this conclusion. But this possibility is ruled out because Arun's (1997) study reveals that this species is abundant in PTR (Table 2.1).

<sup>16</sup> Recent studies (Valsangkar, 1993) show that two species of *Mahseer*, *T. khudree*, and *T.mussullah* had no adverse effect after the construction of dam. According to him, *Mahseers* have adjusted to the changes in ecological conditions consequent to the construction of the dam.

<sup>17</sup> Eighty-five percent of fishermen among the sample also expressed similar views.

<sup>18</sup> The concept of eco-development is recently adopted for biodiversity conservation, with the help of people's participation, through reduction of negative impacts of the people on Protected Areas, environmental education, and impact monitoring and research. It aims at the promotion of long-term sustainable use of resources while caring for biological and cultural diversity. It is one of the most accepted strategies for forest conservation. The Eco-development project at Periyar Tiger Reserve is one among the seven projects in India. Funds for the projects are pooled from International Development Association (IDA) – 41.79 percent, Global Environmental Facility (GEF) –29.85 percent, Government of Kerala - 13.52 percent, Government of India - 8

percent, and villagers contribution - 6.84 percent, totalling Rs 40.54 crore over a period of five years.

<sup>19</sup> Based on the landing data.

<sup>20</sup> This observation is based on the one-year data. For definite conclusions more detailed investigations are necessary. The present study points to the need for a detailed and comprehensive investigation.

<sup>21</sup> Assuming corresponding 10 percent increase in the income from fishing for all the communities taken together.

<sup>22</sup> See Endnote 18.

<sup>23</sup> Footnote 20 applies here also.

<sup>24</sup> Reported at the landing site.

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