TANK FISHERY RESOURCES
OF
KARNATAKA

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TANK FISHERY RESOURCES OF KARNATAKA

by

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FOREWORD

Dr. B.S. Bhimachar, ex-Director, Central Inland Fisheries Research Institute, was the first to conceive of the fishery potentialities of tanks in Peninsular India and had drawn up a programme on their survey and study. Dr. A. David, Fishery Scientist, was given direct charge of the investigations, the results of which are presented in this report. Shri P. Ray, Assistant Fishery Scientist (Chemistry) conducted the physico-chemical analyses of soil and water samples and also carried out some of the correlated studies. Biological samples of weeds, invertebrate fauna and plankton were identified by Shri N.G. Shankaranarayana Rao, Research Assistant, who was also responsible for the survey in 13 districts and major field studies. Shri R.D. Prasadam, Research Assistant and Shri M.F. Rahman, Junior Survey Assistant, surveyed 4 districts each and the former also greatly helped in the analyses of biological samples. Various contributions by the above workers in their respective fields are under preparation.

The late Shri V.V. Kalyani, former Director of Fisheries, Karnataka, facilitated observations in several centres through his Divisional Officers and the major data on tank resources were furnished by the Public Works Department and Irrigational Engineer, all of whose help is thankfully acknowledged. Shri G.L. Rao, Director of Fisheries, Karnataka, readily provided facilities for work in tanks on the lines envisaged for which the Central Inland Fisheries Research Institute is highly obliged.

V.G. Jhingran

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TANK FISHERY RESOURCES OF KARNATAKA

INTRODUCTION

India is the most irrigated country in the world where monsoon rains demarcate clearly the dry and wet seasons of the year, necessitating building of water storage or diversion facilities to tide over long dry spells. Any area having a rainfall of 10 inches (25.0 cm) or less, cannot do without irrigation. But in the arid areas of the Punjab and Rajasthan and in drier parts of Peninsular South India with rainfalls between 40.0 and 100.0 cm, various irrigational methods are adopted to divert river water or store the surface runoff water as the case may be. In South India, almost the entire precipitations occur in the 3-4 months of South-West monsoon and numerous water impoundments are created in a terrain amenable easily for construction of small or big dams with considerable storage potentialities. Andhra Pradesh, Karnataka and Tamil Nadu States, located in the rain shadow of Western Ghats, are for centuries, dependent upon such stored water for irrigation. As opposed to the sprawling North Indian Indo-Gangetic plain, where barrages and canals divert huge quantities of rain and snow water direct from the main rivers to vast fields, the southern region is an elevated, but rolling tableland, topographically suited for storing water during floods within the courses of streams and minor rivers. Many small constructions are built across streams that become activated during monsoon, and majority across dry beds where flash-floods occur. Early earthen and stone dams impounding anything from less than 5 to as much as 5,000 acres (from 2.02 to 2,020 ha) water spread areas serving village land-holdings, still account for a more extensive irrigation, than the precision built dams of recent years.

The tanks and ponds in Peninsular India, are characteristically different from tanks in northern and north-eastern States of India, being mainly irrigational and not mere depressions containing rain or subsoil waters. Exact information on the nature and fish productive capacity of various types of tanks, is not available in India. Though within the past 15-20 years, such data relating to tanks in West Bengal,

Orissa, U.P. etc., have been collected, no systematic production studies correlated with physico-chemical and topographical factors over a number of years, have been made, even though stocking of tanks by quality fish has been intensified. In the extensive inland water resources of Andhra Pradesh, Karnataka and Tamil Nadu the potentialities, magnitude and limitations of fish production have not been fully appreciated. The Tank Fisheries Research Unit was added to the Central Inland Fisheries Research Institute, with its temporary headquarters in Karnataka in late 1962 for assessing the capacity and scope for developing the available water resources for fish yield by collecting all available information in the three States, and by random sampling surveys. Such surveys have already been made from an administrative angle both in Andhra Pradesh and Tamil Nadu by the respective Departments of Fisheries which have advanced greatly the management and stocking programmes of tanks in the two States. The present report refers to the State of Karnataka and the problems and recommendations may hold good to other parts as well in Peninsular India, with certain modifications.

GEOPHYSICAL FEATURES

The State of Karnataka consists of 19 districts of 172 taluks, and lies between 11°-35' and 18°-25' north latitude and 74°-14' and 78°-31' east longitude. It has an area of 74,681 sq. miles (1,93,349 sq. km) and is mainly an elavated plateau (except for a narrow western coastal strip, with hillocks of about 300-400 ft or 88-120 m). It rises almost abruptly through the Western Ghat mountains to about 3000 ft (900 m) which slopes to an average of 1500 ft (450 m) in the south, central and northern districts, with isolated peaks rising to 6,240 ft (1896.0 m) in central part of Western Ghats.

Nearly 58,000 sq. miles (1,50,162 sq. km) of the State is occupied by the oldest rock formations of Archaean Complex, known as Dharwar and Granite gneisses systems. Dharwar Schists consists of ultra-basic rocks and masses of intrusive basic igneous metamorphic rocks, and the granotoid gneisses - those known as Champion gneisses, Peninsular

gneisses, Charnokites and Closepet granites. Central districts e.g., Dharwar, Bellary, Chitradurga, Shimoga (east) and Chikamagalur, possess Dharwar Schists and those of Bangalore, Tumkur, Mandya, Mysore, Hassan and Kolar the granotoid gneisses. These rocks are acidic in nature, and weathering have formed the characteristic red soils of Central and South Mysore. Northern margins of the State possess sedimentary rocks of post-Dharwar age known as Cuddappah Kurnool formation - "Deccan Traps", occupying Bidar, part of Gulbarga, Bijapur and Belgaum districts. The western taluks of Shimoga and Chickmagalur, almost all of the South and North Canara districts, and some isolated pockets in Belgaum, Bangalore and Hassan, are covered by laterite formations. More recent formations of rocks (Pleistocene) are found in the West coastal belt, overlying which are again laterites.

From the physico-graphic features, climatic conditions and also roughly by the nature of soils, the state can be classified into three distinct natural divisions e.g. the Coastal plain, the 'Malnad' and the 'Maidan' (Sketch map 1).

The Coastal Plain :

The Coastal plain of about 2,000 sq. miles (5,178 sq. Km) comprising mainly of North and South Canara districts is about 150 miles (240 Km) long and with a maximum width of about 30 miles (48 Km) in South Canara near Mangalore. It is a sea level plain with a rainfall of about 120 inches (310.0 cm) to 130 inches (330.0 cm) per year. As South-east monsoon clouds are interupted by the steep escapements of the Western Ghats, the heavy rainfall has resulted in numerous short seasonal and perennial rivers (30 to 40 miles or less in length) cutting across the plain. These rivers have also served to deposit some minor patches of alluvium, the only known alluvial soil in Mysore, besides the narrow stretch of the Don river in Bijapur district. Otherwise, lateritic soils are found in common with the Malnad areas on the plateau. Temperatures range in this area between 18° and 35° C and the air is charged with humidity.

The 'Malnad' :

The Malnad or the mountainous and densely forested belt of about 235 miles (376 Km) in length stretching from Khanapur in Belgaum to North Coorg and 35 - 50 miles (56-80 Km) wide covering an area of about 9,500 sq. miles (28,000-30,000 sq. Km) in Dharwar, Shimoga, Chickmagalur, Hassan and Coorg districts, is distinctive with an average heavy rainfall of 200-300 inches (500.0 - 750.0 cm) per year. The second highest rainfall in India is recorded at Agumbe in Thirthahalli taluk of Shimoga district, being about 300 inches (750.0 cm) per year. Evergreen and semievergreen forests in the Malnad tracts cover an area of about 1,300 sq. miles (3,400 sq. Km) where rainfall ranges between 75 and 100 inches (190.0 and 255.0 cm). The adjacent moist deciduous forests occupy about 850 sq. miles (2,200 sq. Km) in the rainfall belt of 50 and 75 inches (125.0 and 190.0 cm). The abrupt and precipitous nature of Western Ghat mountain ranges in the west and their gradually sloping "transitory" area eastwards merging into the plains or 'Malnad' area, is peculiar to these districts. Rainfall diminishes eastwards very rapidly to about 30 to 50 inches (75 to 125 cm) in which region are also found the 3,020 sq. miles (7,800 sq. Km) of dry deciduous jungles.

The Malnad region feeds all the main rivers of the State i.e. the Tungabhadra, and some of the tributaries of the Krishna (Malaprabha and Ghataprabha) and the Cauvery. The highly rated hydel-potential rivers - Sharavathi and the Kalinadi are situated in the region but flow westwards through deep ravines to the Arabian Sea.

The 'Maidan' :

The gently sloping open country, eastwards of Malnad comprising the major area of Karnataka (65-70%) from northern Bidar to Southern Mysore district is called the 'Maidan' region. It is highly undulating in the central and south districts as compared to the northern districts, and is devoid of any dense forests except for the thorny, bushy types totalling to about 8,400 sq. miles (22,000 sq. Km). Average rainfall ranges between 22 and 30 inches (57.0 and 76.0 cm),

but seldom exceeds 30 inches (63.0 cm) in Kolar, Chitradurga, Bijapur, Bidar and Gulbarga districts. Bellary district has the lowest rainfall of 22 inches (57.0 cm) in the State.

Maidan zone can be further subdivided into two main divisions : (a) Central and Southern Red Soil Regions mainly in a rolling terrain and (b) Northern Black Cotton Soil Region, an almost levelled plain. These are found to influence the water quality of tanks very significantly in matters of water retentivity and fertility. It is in this Maidan tract, subjected to scanty or insufficient rainfall, storage of water being a dire necessity, the more extensive storage tanks are found.

On the whole, Karnataka has a monsoon tropical climate, bulk of the rainfall being received during the south-west monsoon between the end of May to end of September. The north-east monsoon sets in October, but its effect is felt only in the south-eastern districts but failures of both or any one of the monsoon rains, dries up most of the tanks. Hence, irrigational tanks and their storage levels are determined according to the rains within the small or big catchments, elevations, proximity to hills as well as soil and irrigation requirements.

The drainage of Karnataka plateau with the exception of the Sharavathi and the Kalinadi (an some minor rivers), is easterly towards the Bay of Bengal through the Maidan, sources of all perennial rivers being the Western Ghats. The slopes of 4-6 ft (1½-2m) per kilometre renders them torrential in the hilly Malnad and lower down they are still rapid due to a steep gradient except for short lengths in the plains of Belgaum and Bijapur districts. A short stretch of the Manjira in Bidar district, represents the Godavari drainage in the State. Otherwise over 60% of the state is served by the Krishna catchment, with its tributaries - the Bhima, Don, Malaprabha and Ghataprabha, Tungabhadra, Hagari etc., in majority of the northern and central districts. Coorg, Mysore and Bangalore districts are served by the Cauvery and its tributaries like the Kabini, Shimsha and Arkavathi. North Pennar and the Palar which are only seasonally active rivers, originate around the Nandi hills, and drain parts of Kolar and Bangalore districts.

METHODOLOGY IN DATA COLLECTION AND SAMPLING

Information on available water resources were first collected from the P.W.D. (Irrigation), Revenue, Forest and Fisheries Departments, which variously control construction, maintenance, water supply or regulation as well as disposal of fishing rights. Lists of tanks with information as to water holding capacity etc., were collected at most of the district and many of the taluk headquarters. As tanks in Karnataka are characterised as 'Major' or 'Minor' and not 'seasonal' or 'perennial', depending upon the 'achkat' (ayacut) i.e. the commanded area (fixed at over 100 acres for a 'major' tank), individual tanks listed had to be ascertained during surveys for their seasonal or perennial nature. Actual tank sites were visited for a sampling programme where Proformae (appendices 1A, 1B & 2) - on water impoundment survey were completed by the staff members at the tank sites, and water samples analysed on the spot for pH, alkalinity, total hardness, turbidity etc. Water and soil samples for other major chemical studies were seperately obtained. Plankton collections, littoral and wherever possible bottom biota collections were made, preserved and examined in the laboratory.

RESOURCES OF TANKS IN KARNATAKA

Tanks as denoted in Peninsular India refer to both the 'ponds' and 'lakes' constructed for a specific purpose e.g. irrigation, drinking, water supply, washing and bathing as the case may be. Most of the tanks being irrigational in utility, retain water from a few months to a year, when they have to be replenished by rains. These tanks differ from 'lakes' in N. America or elsewhere, being very shallow and hence uniformly warm. Similarly, tanks differ from the storage reservoirs in India in water holding capacity and average depths. Most tanks also differ from 'ponds' in the sense that ponds are less than one acre in extent or so. An arbitrary attempt is now made to distinguish the ponds and tanks, reservoirs and lakes for want of clear descriptions and to avoid any confusion in the present report.

Characteristic Features :

The natural lakes formed by glaciation, land slides, leaching of substrata, crustal movements of earth or extinct volcanoes are virtually absent in India. Except for some forest lakes of small dimensions in isolated hilly parts of Western Ghats, naturally formed impoundments are not observed in Karnataka. There are also no swamp as the terrain is rocky and water drains off quickly. Brackishwater/backwaters are rare along the coastal strip owing to high gradients. The small ponds loosely termed as "tanks", are situated in almost all towns and villages or are close to the temples as sources of water for drinking, washing etc. The following differences are now noted :

Reservoirs	Tanks/Ponds
i. Water sheets of above 2 sq. miles (550 ha) or so in extension, but with much higher water capacity per unit surface area, being more than 20-25 ft (6.0 to 7.5 m) in average depth in summer for 75% or more of its surface area.	i. Impoundments of generally under 1,200 acres (500 ha) in surface area, but with poor water capacity per unit surface area, being below 15 ft (4.5 m) in average depth for more than 75-80% of its area.
ii Formed by dams built with precise engineering skill across perennial or long seasonal rivers or streams, using concrete, masonry or stone for power supply, large scale irrigation or flood control purposes.	ii. Built of rubble, earth, stone and masonry work across short seasonal streams.

iii. Usually free from water weeds and subjected to great fluctuations in water levels and depths. Biotal life, plankton, fish etc. are sparse.

iii. Water weeds commonly observed, being shallow. Biotal life and fish density high.

It is of some interest to mention certain basic differences in tanks of Northern and Southern India.

North Indian Tanks	Peninsular Indian Tanks
i. Tanks are comparatively few in numbers, formed in depressions in alluvium and silt over plains. Exacavated tanks are formed by removal of earth in the plains where water table is quite high, and water retention is also high.	1. Tanks numerous, being built by throwing a low bundh across a stream, and generally over hard rocky substrata within an undulating terrain. Silt and mud on bottom dependent upon aging. Water retention poor.
ii. Connected with spills and inundations from main rivers and if merely depressions, are filled by rain water collected from surrounding fields. Tanks are also isolated.	ii. Tanks are connected with one another, depending upon direction of stream flow, elevation and contour.
iii. If used for irrigation, water is lifted or pumped. More or less uniformly deep owing to bundh on all sides, and depths are not subjected to great variations.	iii. Subjected to considerable variations in depth due to gravitational drawdowns through sluices fitted into the bundh, which occupies only a short peripheral length. With exposed bottom over a wide area. Depths increases only towards the bundh.

iv. Salts and nutrients are generally rich in tanks over a wide range of territory.	iv. Nutrients and salts variable from tank to tank even within close proximities, generally with lower fish production capacity unless treated with suitable fertilisers.
v. Incursion or presence of faster growing species adds to fish productivity; productivity potential high. Fish species are determined by inundation from main rivers. Few self-propagating forms of some importance in the tanks themselves, and forms available are uniform in composition over a wide area and from year to year.	v. Species of fishes vary from tank to tank in composition and almost all are slow growing or small sized; fish can hardly be eradicated from perennial tanks but always are denuded from seasonal tanks. Those forms are mostly self propagated in tanks or its adjuncts and many 'invade' tanks during floods, hence there is a change in composition of fish from year to year depending upon rain and flood conditions, survival, reproduction success of fish species etc.
vi. Single ownership or control of tanks by individuals or Governmental agencies or Panchayets.	vi. Multiple control by various Governmental agencies or Village Panchayets.

Tanks in Karnataka, have usually a 'bundh' or wall of loose rubble and earth and occasionally of masonry stones constructed by villagers themselves. These bundhs can be as high as 30 ft (10 m) in larger tanks but may cover a length of 1/10 to 1/4 of the periphery. The tanks are deepest near the wall through which one or more sluices of stone, masonry or cement are fitted according to water requirements. Screw or lift type flat wooden or iron sheet gates fixed to iron bars are fitted to the sluice openings. Water outflow is regulated by lifting the gates from the top manually. In smaller tanks a cylindrical wooden plug through a round hole carved in a

flat stone slab, similarly regulates the flow. One or two surplus outlet channels or raised stone wall are also provided to protect the bundhs from being eroded during excessive flooding.

The 'Gokattes' are perennial small tanks across seasonal streams to serve as drinking water sources for cattle and have no sluices but only waste weirs. Such 'Gokattes' are found mainly in Bangalore, Mandya and Mysore districts. A number of fortmoat ponds especially in Bijapur, Belgaum and Bellary districts are also found. Almost all the numerous small temple ponds, town municipal tanks and village ponds are 'closed' tanks without provision for outflows, but larger such tanks may have overflow outlets.

Source of water supply being mainly the rains, incursion of rain-water into tanks is by bundh in a seasonal stream or by collecting water within a tank from the surrounding trough like catchment over fields. Surplus water from one tank drains into the tank below and a series of such chains of tanks are usually created in the sloping, undulating terrain even within short distances. In the plains, tanks are more isolated and spread out in more or less level areas, and are with bundh or even excavated where chances for accumulation of water are high. In many tanks, rain water from almost a level catchment is thus collected where no streams may be found above. Infact, nearly 13% of annual run off of water in Karnataka, is estimated to be stored in tanks.

A channel from each of the sluices, serves to supply water by gravity to the commanded area ('achkat' or 'ayacut'). Average land area irrigated per 1,000 acres (400 ha) water-spread in a tank is about 150 acres. It has ranged between 144 and 190 acres in various districts.

Usually wet crops - paddy and sugarcane, as well as plantation crops - arecanut or banana groves etc., are served by the tanks. Even dry crops - maize, ragi etc., are also irrigated by tanks. In Karnataka, as against 2,35,716 ha irrigated by canals from reservoirs and river headworks, 3,48,572 ha are irrigated by tanks of all types i.e. of the 8.4% of total area irrigated by canals and tanks, 6% is served by tanks alone.

As there are large tanks considered almost as reservoirs and there are wide spread seasonal tanks as also very small perennial tanks serving irrigation needs, a rough categorisation is now attempted to denote them.

Perennial Tanks :

A complete list of tanks district-wise over the State is furnished in table 1. These do not include the reservoir-like tanks of over 1,000 acres (400 ha), which are listed seperately in table 2. A total of 2,155 perennial irrigational tanks of under 400 ha water spread are found in the state, covering an area of 1,46,410 acres or 58,436 ha. These form 9.4% of total number of all tanks (inclusive of seasonal tanks) and 21.4% in water spread excluding tanks over 400 ha. Inclusive of the latter, perennial water tank-spread is 28.4%.

These tanks being small, are apt to dry up if normal rain fails in the region. Smaller the capacity and water spread, greater is the shrinkage in tanks in drier belt of the State as compared to larger tanks in the wet belt. On the whole, the perennial tanks of this category shrink about 45.5% on an average, barring bad drought years when most of them dry up.

The numerous ponds or 'kuntes' i.e. small, under one acre water spread ponds found every where adjoining or inside each village, town or city or attached to temples, within plantations and orchards etc., are not included in the above lists.

From table 1, it is apparent that perennial tanks (under 400 ha) are the highest in Coorg being 9, and in Hassan being 6 per 100 sq. Km land area, closely followed by Shimoga, Tumkur and N. Canara (2 each). While Shimoga has the highest water spread - 285 acres or 103 ha per 100 sq. Km, Mandya district shows 243 acres with Tumkur, Hassan, Mysore, Chitradurga and Bangalore districts showing 171, 155, 143, 122 and 103 acres respectively per 100 sq. Km. Hence the above districts have the highest percentages of cultivable water-sheets. Poorest are Raichur, Gulbarga, Bidar and Bijapur, with only 6, 17, 24 and 27 acres per 100 sq. Km, respectively, indicating clearly that the poor rainfall and flat terrain are discouraging factors for construction of irrigational tanks in northern Mysore. Even though Kolar district has only 8 perennial tanks with a total water-spread of 5,343 acres, it is augumented by 7,359 acres (table 2) by six tanks of over 1,000 acres. A number of seasonal tanks, have turned into perennial water-sheets owing to canal connections from reservoirs on main rivers in Mandya, Bellary, Raichur, Shimoga and Chitradurga districts.

There are 32 reservoir-like tanks of over 400 ha (1,000 acres) in Karnataka (table 2; Sketch map 2). They present a water spread area totalling 23,909.3 ha, which is 29.03% of total perennial water-spread of 82,345 ha in the State. Their water spread and capacity in proportion being very large, each tank irrigates between 5,000 - 12,000 acres of land. Daroji tank in Bellary district, is a seasonal tank that has become perennial in 1966 by canal connection from the Tungabhadra high level canal. The shrinkage of these tanks of over 400 ha in water spread is about 30% on an average, and hence over 16,000 ha are available for fish cultivation programme all through the year.

Considering perennial tanks of both categories totalling 82,345 ha (max.), area available for fish cultivation programme within the state is 48, 150 ha even at the minimal water levels.

TABLE - 1

DISTRIBUTION OF TANKS IN RELATION TO AREA OF DISTRICTS

(Excluding Tanks over 400 ha water-spread)

District	Area in sq. Km	Total No. of tanks	Total WSA in ha	Total No. of Perennial tanks	No. of Perennial tanks in 100 sq. Km	Total WSA of Perennial tanks in ha	WSA of Perennial tanks per 100 sq. Km	Total No. of seasonal tanks	Total No. of seasonal tanks in 100 sq. Km	Total WSA of seasonal tanks in ha	WSA of tank in 100 sq. Km
Bijapur	17078	52	2486	18	1	1906	27	34	1	580	8
Gulbarga	16400	213	7161	16	1	1127	17	197	1 (Approx.)	6034	91
Raichur	14222	903	6094	10	1	358	6	893	6	5736	99
Dharwar	13735	159	3349	93	1	2937	53	66	1	412	7
Belgaum	13372	754	3827	20	1	1282	23	734	5	2544	47
Mysore	11958	633	16899	40	1	6931	143	593	5	9968	806
Chitradurga	10839	344	35257	32	1	5370	122	312	3	29887	681
Tumkur	10609	1297	37952	280	2	7379	171	1017	9	30573	712
Shimoga	10531	7158	28421	272	2	12140	285	6886	65	16281	382
N. Canara	10269	316	1028	252	2	815	19	64	1	213	5
Bellary	9907	140	6024	12	1	1630	40	128	1	4394	109
S. Canara	8415	39	88	23	1	56	1	16	1	32	1(appro
Kolar	8257	1999	49768	8	1	2162	66	1991	24	47606	142
Bangalore	7980	1793	22628	102	1	3340	103	1691	21	19288	597
Chickmagalur	7218	2561	7689	122	1	789	27	2439	34	6900	236
Hassan	6832	3429	30260	430	6	4306	155	2999	43	25954	938
Bidar	5488	29	732	7	1	548	24	22	1	184	8
Mandya	4383	455	12270	20	1	4399	243	435	9	7371	265
Coorg	4110	469	474	398	9	460	28	71	1	14	2
Totals		22743	272407	2155		58436		20588		213971	

TABLE - 2

Tanks above 1,000 acres (400 ha) in W.S.A. in Karnataka

Sl. No.	Name of the Tank	District	Area in acres	Area in Hectares	Total W.Sp. in districts	
					Acres	Hectares
1.	Muchugandi tank	Bijapur	1024	414.4	2164	875.8
2.	Ramanahalli tank	"	1140	461.4		
3.	Narasambudi tank	Mysore	1210	489.7		
4.	Bandipur tank	"	2843	1150.6		
5.	Kavigala Doddakere	"	1700	688.0	9642	3902.1
6.	Honganur Doddakere	"	2305	932.8		
7.	Ramasamudra Doddakere	"	1584	641.0		
8.	Bhimasamudra	Chitradurga	1720	696.1		
9.	Dharmapura Amanikere	"	1000	404.0	5212	2108.6
10.	Morasabihalli Ranikere	"	1348	545.5		
11.	Jajurkere	"	1144	463.0		
12.	Boranakanive	Tumkur	3320	1343.6		
13.	Doddabomakere tank	"	1000	404.0		
14.	Kunigal Doddakere	"	1083	438.3	8853	3582.1
15.	Nonavinakere	"	1200	485.6		
16.	Mallaghatta Amanikere	"	2250	910.6		
17.	Shantisagar	Shimoga	3600	1457.0	3600	1457.0
18.	Daroji tank	Bellary	2000	808.0	3031	1224.5
19.	Dhanayakanakere	"	1031	416.5		
20.	Byrasagarakere	Kolar	1809	732.1		
21.	Mudavadi Doddakere	"	1026	415.0		
22.	Bethamangala	"	1050	425.0	7359	2978.0
23.	Ramasagara	"	1200	485.6		
24.	Gandedy Doddakere	"	1105	447.2		
25.	Amani Bhadrankere	"	1169	473.1		
26.	Marlavadi tank	Bangalore	2100	850.0		
27.	Amani Doddakere	"	2810	1137.2	6309	2553.4
28.	Hessaraghatta	"	1399	566.2		
29.	Vishnusamudra	Chickmagalur	1313	531.4	1313	531.4
30.	* Maddur Doddakere	Mandya	4769	1930.0	9905	4008.5
31.	Arasikere Sulekere	"	5136	2078.5		
32.	Kadaba	Tumkur	1700	687.9		
			59088	23909.3		

* These tanks being silted and weed infested are now just under 1000 acres each in extent.

Seasonal Tanks:

Seasonal tanks in the State number 20,588 with a total waterspread of 5,28,759 acres (2,13,971 ha.) i.e., nearly 90.6% of total number of tanks and 78.6% of water area (of tanks only under 1,000 acres) are contained by seasonal tanks. Majority of seasonal tanks retain water from June to March i.e., 9-10 months in a year. It is not possible to categorise correctly seasonal tanks as even transitory tanks of one or two acres retaining water for just a month or two, are classified as tanks in Gulbarga, Bijapur, Belgaum, Bidar and Kolar districts. But in areas of heavy rainfall and in the transitional slopes between Malnad hills and the dry Maidan, seasonal tanks retain water for major part of the year. In table 1, details of distribution of these tanks are given. Shimoga district shows the largest number, i.e., 6,886. Hassan, Tumkur, Chitradurga, Bangalore, Shimoga, Mandya, Chickmagalur and Mysore with 938, 712, 681, 597, 382, 265, 236 and 206 acres of waterspread respectively per 100 sq. Km indicate the trends of distribution. It is also to be noted that the above districts are continuous to one another, and the distributory trends follow the rainfall pattern.

Basically, in water retaining capacity, depths and nature of bed, seasonal tanks differ from the perennial tanks. These are usually very shallow, generally devoid of any vegetation.

LIMNOLOGICAL (Physico-chemical, Biotal and Planktonic) FEATURES

In tables 4, 5, 6 and 7 the soil-water conditions, tank vegetation, littoral and bottom fauna and plankton respectively as determined during survey of 344 tanks (217 perennial tanks and 127 seasonal tanks) in the 17 districts (table 3) actually covered, are indicated. Lists of various flora and fauna tentatively identified, are also given. As the entire study was directed towards determination of rough biological productivity of tanks ultimately resulting in fish, various factors are sought to be correlated zonewise as already mentioned. A "Transitional" zone between Malnad and Maidan on the basis of rainfall was recognised during this study (Sketch maps 1 & 3).

TABLE - 3

Districtwise maximum and minimum waterspread in Perennial Tanks surveyed

Sl. No.	District	Total No. of perennial tanks examined	Water spread area in acres		Percentage of minimum waterspread area	Percentage of submergable area exposed
			Max.	Min.		
1.	Bijapur	12	3417	2232	65.3	34.7
2.	Gulbarga	14	2695	2264	84.9	15.1
3.	Raichur	12	1277	441	34.5	65.5
4.	Dharwar	13	3099	1533	49.4	50.6
5.	Belgaum	13	344	158	49.9	50.1
6.	Mysore	12	2341	1152	49.1	50.9
7.	Chitradurga	13	8640	6630	76.7	23.3
8.	Tumkur	18	12496	5770	46.1	53.9
9.	Shimoga	24	1758	1162	66.1	33.9
10.	N. Canara	4	91	54	59.3	40.7
11.	Bellery	17	6320	1416	27.1	72.9
12.	Kolar	8	4698	3305	70.4	29.6
13.	Bangalore	19	2223	843	37.9	62.1
14.	Chickmagalur	5	1942	1187	61.1	38.9
15.	Hassan	16	3882	1809	46.6	53.4
16.	Bidar	6	1256	672	53.5	46.5
17.	Mandya	11	2273	1170	48.5	51.5

Average 45.5% acre exposed i.e. extent of reduction of tanks during summer in the State.

TABLE - 4

Showing Chemical Constituents of Water and Soils in Sampled Tanks

Zone and Nature of soil	District	WATER					SOIL						
		pH	D.O. (ppm)	Alk. (ppm)	Hardness (ppm)	Sp.Cond. X 10^{-6} mhos. at 25°C	pH	Ca	Mg	P_2O_5	NO_3	NH_3	Sp.Cond. X 10^{-6} at 25°C; 5:1000 soil suspension
							(The values given are pounds per acre)						
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
I. Coastal Zone (Lateritic Soil)	N. Canara Range	7.9-8.0	3.1-8.6	8-28	12-28	32-132	5.0-7.0	500-2000	250-1000	25-250	15-100	25-100	86-115
	N. Canara Average	8.0	5.9	18	19	80	6.0	937	375	99	22	56	94
II. Malnad Zone (Lateritic and Red Soil)	Belgaum Range	6.8-8.6		25-450	44-110	151-920	5.0-7.7	500-6000	250-1000	25-125	Nil-25	15-100	45-250
	Belgaum Average	9.0	6.2	117	67	754	6.1	2601	480	69	9	40	110
	Dharwar Range	8.0-9.1	7.8-11.7	16-188	48-160	124-433	6.5-8.5	1000-6000	225-1000	25-200	Nil-25	5-100	153-884
	Dharwar Average	8.2	9.3	118	96	323	7.5	3625	681	77	11	42	430
	Shimoga Range	6.8-8.0	8.0-13.0	14-24	11-36	179-421	4.5-6.5	500-1000	Nil-500	43-94	5-75	50-100	80-300
	Shimoga Average	6.8	9.7	16	21.3	213	4.6	711	247	69	6	19	162
	Chickmagalur Range	8.3-8.6	7.4-15.2	72-200	120-196	164-205	7.5-7.9	500-4000	250-1000	50-100	Nil-25	25-100	51-343
	Chickmagalur Average	8.4	11	153	158	427	7.8	2250	262	84	17	56	139
	Hassan Range	8.0-8.7	4.2-10.3	76-136	80-128	242-358	6.6-8.4	500-6000	250-2000	25-125	Nil-25	25-100	44-176
	Hassan Average	8.3	8.4	103	79	309	7.4	1543	859	68	14	60	81
III. Transitional Zone (Red Soil)	Shimoga Range	6.8-7.9	3.8-14.4	20-63	40-72	160-434	3.9-7.0	500-5000	250-1000	25-125	Nil-5	50-100	57-235
	Shimoga Average	7.2	8.1	43	57	278	5.7	2150	400	60	2	70	124

contd.....

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
	Range	8.5-8.9	3.4-18.4	160-352	112-196	353-1121	7.2-7.5	500-6000	500-2500	52-200	5-25	25-100	46-104
	Chickamagalur Average	8.6	10.1	233	149	737	7.3	2000	1083	137	15	62	75
	Range	8.0-8.9	8.0-10.6	112-276	92-180	418-1250	8.8-8.4	500-6000	250-2000	25-200	Nil-25	15-100	65-281
	Hassan Average	8.5	9.1	213	139	620	7.5	3300	984	92	12	42	134
	Range	8.0-9.1	7.0-15.8	112-348	76-196	333-778	6.6-8.4	500-6000	250-2000	25-100	Nil-25	5-100	41-778
	Mandya Average	8.6	10.8	177	128	459	7.2	2596	1096	63	14	56	164
	Range	8.0-9.5	4.5-13.3	90-400	80-232	176-938	6.6-8.5	500-6000	250-2000	25-200	Nil-200	5-100	57-371
	Mysore Average	8.7	8.1	225	150	573	7.6	3403	894	64	20	44	126
IV. Maidan A. Black Soil Zone	Range	7.3-8.3	5.6-8.8	60-200	70-120	177-1704	7.8-8.2	500-6000	500-1000	25-75	Nil-25	25-100	76-294
	Bidar Average	7.8	7.0	117	90	564	8.0	3583	666	45	10	31	217
	Range	8.0-9.5	8.0-24.9	50-600	35-130	109-2000	6.6-8.2	500-6000	250-2000	25-200	5-25	15-100	125-727
	Gulbarga Average	9.0	13.7	263	18	654	7.7	4396	729	82	18	53	234
	Range	4.0-9.5	4.0-7.5	110-365	60-200	136-7666	7.0-8.2	4000-6000	250-2000	25-500	5-15	25-100	92-659
	Bijapur Average	7.9	6.3	182	70	1197	7.9	5100	990	81	10	48	357
	Range	8.0-9.6	3.3-11.9	28-320	10-125	76-1352	6.5-8.5	2000-6000	500-2000	25-200	5-25	15-100	76-209
	Raichur Average	8.6	6.6	130	52	404	7.8	3916	1250	125	15	39	130
	Range	8.1-9.1	6.1-14.11	62-188	56-120	124-500	7.0-8.5	1000-6000	250-2000	25-125	5-25	5-100	163-741
	Dharwar Average	8.5	8.8	120.5	85	297	7.9	3916	854	70.8	13.3	42	327

contd.....

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
	Range	4.4-9.2	8.4-9.1	64-252	52-224	230-2000	6.8-8.5	<500->6000	500-2000	<25-200	Nil-15	25-700	88-38
	Chitradurga Average	8.8	8.5	108	97	732	8.0	3533	1178	69	4	84	162
V. Maidan B. Red Soil Zone	Range	7.9-9.5	3.8-7.0	44-268	40-116	126-1050	5.5-8.5	500-6000	500-2000	<25-200	Nil-25	5-100	82-45
	Bellary Average	8.3	5.1	125	58	373	7.7	3117	1169	71	13	52	170
	Range	6.8-8.8	4.3-10.0	55-178	30-132	51-495	6.6-8.5	500-6000	<250-2000	<25-225	Nil-25	25->100	32-31
	Tumkur Average	7.2	7.3	88	70	185	7.3	2671	730	71	9	61	94
	Range	7.3-8.8	6.4-12.4	40-188	47-200	135-1146	6.6-8.5	<500-6000	500-2000	<25-200	Nil-25	25-7100	31-25
	Kolar Average	6.8	6.2	94	88	474	6.1	1242	800	54	14	65	112
	Range	6.8-8.3	5.1-14.1	40-116	38-98	71-411	5.5-8.0	500-4000	50-2000	<25-200	Nil-25	25->100	31-29
	Bangalore Average	7.3	8.0	61	58	214	7.0	1000	545	82	15	68	253

TABLE - 5

List of aquatic vegetation (genera) recorded during survey

	TYPE	GENERA	Distribution and Remarks
I.	Littoral	Jussiaea	- Very common
		Polygonum	- Common in Central and Southern Districts
		Typha	- Raichur, Belgaum and Dharwar
		Cyperus	- Mostly in Northern and Malnad tanks
		Scirpus Pseudoraphis	- Mainly Malnad tanks of Shimoga, Chickmagalur
		Ipomoea	- Malnad and Gulbarga Dist. tanks
II.	Submerged	Hydrilla	- Common all over the State
		Chara	- Restricted to Central and Southern districts
		Nitella	- -do-
		Ceratophyllum	- Isolated distribution
		Naias	- -do-
		Potamogeton Aponogeton	- Common all over the State, abundant in Southern and Central districts
		Utricularia	- Malnad tanks only
		Vallisneria	- Tnaks in most districts
III.	Floating	Lemna Wolffia	- Common in small village tanks
		Pistia	- Malnad tanks
		Eichhornia	- Restricted to Bangalore, Mysore and Gulbarga tanks only
IV.	Emergent	Nelumbo	- Shimoga, Chickmagalur, Mandya only
		Nymphaea	- Mostly in Shimoga, Belgaum, Dharwar, N. Canara, Tumkur tanks
		Limnanthemum	- Mostly in Dharwar, Shimoga, Tumkur Districts
		Trapa	- Mostly in Shimoga, recorded all over Bangalore
		Marsilia	- Isolated distribution all over the State

TABLE - 6

LIST OF BIOTAL ORGANISMS (INVERTEBRATE) OF DIFFERENT FAMILIES ENCOUNTERED IN THE TANKS OF KARNATAKA

Worms :				
	Oligochaetes		Tubificids	Almost all tanks in the State.
			Chaetogaster, Stylaria, Nais	Belgaum and Bangalore Districts.
	Hirudinea		Hirudo spp.	Bangalore, Malnad Zone.
Insects :				
	Ephemeroptera	Baetidae	Baetis	Almost all districts
			Siphlonurus	-
		Caenidae	Caenis	Almost all over the State except Northern dist. tanks, Bidar, Bijapur and Gulbarga.
	Odonata			
	Zygoptera	Agrionidae	Ischnura	All over the State.
	Anisoptera	Libellulidae	Libellula, Dythemis	
	Hemiptera	Corixidae	Corixa	-do-
		Notonectidae	Notonecta	Isolated
		Belostomatidae	Belostoma	Belgaum, Dharwar and N. Canara.

contd.....

Table-6 Contd...

			Sphaerodema	-
		Gerridae	Gerris	Recognised in Tumkur and Mysore tanks.
		Nepidae	Nepa Ranatra	Isolated distribution
	Coleoptera	Hydrophilidae	Tropisternus Berosus Loccobius	Isolated tanks
		Dytescidae	Hydroporus	Isolated tanks
	Trichoptera		Polycentropies	
	Neuroptera	Sialidae		
	Diptera	Chironomidae	Chironomids	Common in all tanks
		Tabanidae	Tabanus	Fairly well distributed
		Centropoganidae	Cuticoides	Common
		Ephydridae	Ephydra	Bangalore Dist. only
		Culicidae	Mosquito larvae and pupae	Common
Molluscs :				
	Gastropoda		Viviparus Lymnaea Planorbis Gyraulus	Common all over
			Pila	Restricted to large perennial tanks.
	Bivalves		Unio	Rarely recorded
Crustacea :	Caridina (Prawns)			Common in most of the Perennial tanks

TABLE 7

Districtwise average values of various groups of plankton (No. per litre)

	Family/Genera	Coastal and Malnad Zone						Transitional Zone					Black Soil Zone						Red Soil Zone			
		North Canara	Belgaum	Shimoga	Chick-magalur	Hassan	Dhar-war	Shimoga	Chick-magalur	Hassan	Mandya	Mysore	Bidar	Gul-barga	Bija-pur	Rai-chur	Dhar-war	Chitra-durga	Bellary	Tumkur	Kolar	Banga-lore
1		2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
PHYTOPLANKTON	MYXOPHYCEAE	59	1604	1	-	28	225	13	244	139	74	7806	15	2309	809	11	98	287	28	34	8	1714
	BACILLARIO-PHYCEAE	8	15	13	42	72	5	36	99	276	148	17	39	21	12	33	17	174	12	7	542	252
	DESMIDACEAE	69	21	42	-	8	3	6	18	4	4	6	-	-	<1	-	3	3	1	<1	2	9
	CHLOROPHYCEAE	32	47	12	72	90	7	29	73	32	33	23	259	30	60	1	27	33	3	5	208	10
	Total numbers	168	1687	48	114	198	241	84	434	451	269	7852	313	2360	881	45	146	497	45	46	860	1985
ZOOPLANKTON	PROTOZOA	51	4	25	18	55	18	10	5	4	14	15	31	8	95	3	5	4	2	19	3	52
	ROTIFERA	3	333	12	15	30	189	8	5	49	143	29	131	26	456	4	53	8	8	76	1	52
	CLADOCERA	2	9	-	5	4	-	8	12	4	-	6	9	58	12	7	3	68	3	15	5	12
	COPEPODA	14	94	4	19	88	51	5	32	118	33	90	60	67	110	4	44	255	13	109	17	55
	OSTRACODA	-	-	-	-	2	-	1	-	-	1	3	-	-	<1	-	-	2	-	<1	<1	-
	NEMATODES	-	-	1	-	4	-	-	-	1	1	-	-	1	<1	-	-	-	-	-	-	-
	Total numbers	70	440	41	57	183	258	31	54	176	66	133	231	160	673	18	105	337	26	219	26	171
ZONAL AVERAGE	:Phytoplankton per litre	: 409							1616					707							734	
	Zooplankton per litre	: 158							92					254							113	
	Average plankton counts per litre	: 567							1708					961							847	

Coastal and Malnad Tanks:

Soils and Water Quality:

Lateritic soils of Malnad and the Coastal Plains are derived principally from the underlying igneous rock formations under high humid, high temperature and alternate periods of dry and wet seasons, common to both regions. These lateritic soils are cellular in structure, soft and red to yellow in colour due to hydrated oxides of iron and aluminium which may occur as concretions. They contain only traces of lime, magnesium and potash and are poor in silica, finer fractions of soils like clay and silt. They generally show a low status being base deficient in lime. Occasionally these soils are loamy as in N. Canara. pH varies between 5.0 and 7.0; with an average of 6.0 such soils are poor in plant nutrients, but in the densely forested areas of Malnad, laterites are covered by forest litter, and become very rich in organic matter and nitrogen, but with low base status. Water holding capacity of these soils is poor; water samples from cleared forest tracts and villages, amply reflect these soil characteristics. Though the differences between lateritic and red soils in mineral contents are not very significant, they differ in fertilizing qualities. Because of exposure to sun in a humid area and being bereft of forest cover, coastal laterites determine water quality in tanks somewhat differently from the Malnad tanks, though both areas have a high rainfall (300-400 cm.) annually. Soils of coastal area are both inorganically and organically poor as evidenced by their low values - i.e. pH 5.0-7.0, calcium - 500-2,000 lbs/acre and lower, and specific conductivity - 86-115 $\times 10^{-6}$ mhos. Contribution of such poor soil constitutents to the overlying water is not only insignificant, but any leaching, is offset by heavy rainfalls. Overflow of such tanks washes off the salts as reflected in the poor water quality (pH - 7.9-8.0 alkalinity - 8-28 ppm., hardness - 12-28 ppm. and specific conductivity - 32-132 $\times 10^{-6}$ mhos.).

Soils of lateritic Malnad (sketch map - 3) because of dense forest litter are organically richer and differ basically from the open lateritic and red soils. Disintegration of surface humic matter (mostly fallen leaves), releases elements like calcium, magnesium, and other salts especially if soil pH indicates alkaline character. Exchangeable salts in the presence of humic matter are more readily released, and calcium then tends to shift the acidic pH to the alkaline side values, but would have been higher if there has been no loss by excessive rains and leachings, or by its entering into combination with nitrogen, forming calcium nitrate. Water weeds are thus benefitted by depriving plankton of the use of this salt and hence grow profusely. The higher values of ammonia in Malnad soils further indicate the richer organic content and also the extent of organic disintegration, which would have been greater still if higher temperatures (as in eastern, more open districts) had prevailed at the bottom. Higher the disintegration, a better release of hydrogen ions through various processes, and if these are reached upon by natural lime present, would raise pH above neutrality; otherwise an acidic character would result. Soils and waters in Shimoga district indicated lower values in most chemical constituents, with high ammonia content. The Malnad tank waters on the whole indicated average value ranges of pH - 6.8- 8.4 alkalinity - 16-118 ppm., hardness - 21.3-158 ppm. and specific conductivity - 213-427 x 10^{-6} mhos. A gradual improvement in eastward tanks was also noticed. Only in Belgaum district due to admixture of black cotton soils, slightly higher specific conductivity (754 x 10^{-6} mhos.) was noted. In Malnad tanks, phosphate was either absent or only present in traces; otherwise, these waters can be compared to fairly productive waters. Shimoga tanks (in interior Malnad), indicated acidic pH of 6.8 and lower, with low alkalinity of only 16 ppm and hardness of 21 ppm and specific conductivity of 213 x 10^{-6} mhos.

Biotal studies:

Water weeds: Majority of the tanks in Coastal and Malnad zones are weed infested. Margins of tanks are found choked with hardy Pseudoraphis (Graminae) and Scirpus (Cyperaceae) etc., in addition to submerged and emergent species of all types mentioned in table 5 in Shimoga district. Floating weeds are restricted mainly to Pistia and Lymnanthemum in general in all districts,

with Lemna being more common to Dharwar tanks. In variety and abundance of water weeds, Malnad and Coastal tanks are the richest in the State, even the comparatively rarer forms like, Utricularia, Trapa, etc., being found. No single weed infestation (e.g. Eichhornia) is noted, but the luxuriance of submerged and emergent vegetation presents exceptionally difficult problems of erdication and control here. Hydrilla, Chara and Ceratophyllum constitute the main submerged vegetation in Shimoga, but Hydrilla alone in Dharwar. Vallisneria and Eichhornia are found however rarely in Malnad tanks. Most tanks in Malnad are swampy with various rooted vegetation including Typha or Scirpus rendering middle and shallow open surfaces difficult for fishing by usual methods. A number of tanks are also chocked with Nelumbium.

Littoral and Bottom Biota: Mainly organisms listed in table 6, occurred variously in the Coastal and Malnad tanks as the rich vegetation offers exceptionaly favourable conditions for their shelter and multiplication. Tubificids constituted the main Oligochaetes, Stylaria and Chaetogaster spp. being very rare unlike in tanks of other zones. Similarly, Trichopteran and Neuropteran insects are also not recorded. Being usually associated with disintegrating bottom ooze, their rariety indicates that organically rich muddy soils are uncommon if not absent in these tanks. Amongst Molluscs, gastropods dominated, bivalves being rare.

Plankton: In tanks over lateritic soils particularly in Shimoga and N. Canara districts, Desmidaceae dominated with Myxophyceae, Chlorophyceae being poorly represented; Myxophyceae was richer in Belgaum. Copepods dominated over cladocerans. In most tank samples, cladocerans and ostracods were totally absent. A greater variety of protozoans and desmids characterise tanks in these two zones.

Myxophyceae was represented by forms, like Phormidium and Rivularia in N. Canara and Shimoga, while Microcystis, Anabaena Clathrocystis, Oscillatoria and Cylindrospermum were found in Chickmagalur and Hassan districts. When Microcystis was recorded in abundance, protozoans and rotifers also dominated. With regard to diatoms, total counts though lower in number than in other zones, showed a good variety qualitatively. But with regard to desmids, the Coastal and Malnad tanks are specifically very rich.

As many as 8 varieties (Cosmarium, Selanaastrum, Xanthidium, Microasterias, Closterium, Euastrum, Desmidium, Gonatozygon) are noted in Shimoga Malnad alone, while in N. Canara tanks, Staurastrum and Arthrodesmus in addition were recorded. Diatoms are very poor in N. Canara, Shimoga, Dharwar and Chickmagalur tanks as compared to their density and variety in other zones, though usual forms listed were noted. Chlorophyceae were fairly well represented by filamentous algae, like Spirogyra, Mougeotia, Zygnema, and Oedogonium variously with Pediastrum duplex, P. simplex, Crucigenia, Tribonema, Chaetophora, Microspora etc., also recognised. No tanks with high growth of filamentous algae were found except in some Malnad forest areas.

Protozoan variety is rich in samples from Malnad districts, Arcella, Difflugia, Centropyxis, Euglypha, Actinophrys and Ceratium being recorded frequently to a greater extent than in other zones. Rotifers dominated in tanks of Belgaum and Dharwar, the maximum for this zone as well as all other zones in Karnataka and further dominated in zoo-plankton counts. Keratella was the most abundant form. A very rich variety of Rotifers is now noted to occur in Malnad and Coastal tanks. Cladocerans were poorly represented by Chydorus, Diaphnosoma, Polyphemus etc., which were dominated, however, by Copepods and Nauplii. In all districts of these two zones, average ratio between phyto- and zoo-plankton is 1: 1 (Shimoga, Hassan and Dharwar) and 2: 1 in the remaining districts. Average phytoplankton of 409, zooplankton of 158 and total plankton of 567 per litre were computed from surveyed samples.

Transitional Zone Tanks:

Soil and Water quality:

A mixed zone of higher soil and water fertility is recognisable in the comparatively drier eastern part of Shimoga, stretching through Chickamagalur, Hassan, Mandya and Mysore (sketch map 2 and table 4) adjoining mostly the Malnad area. The soils in this area vary from being lateritic to mostly red. The average ranges of pH = 7.2-8.7 alkalinity = 43-233 ppm. hardness 57-150 ppm. and specific conductivity = 278-737 x 10^{-6} mhos being shown in water quality (all lower values refering to tanks in eastern Shimoga district). A decided improvement is shown over poorer Malnad tanks, though in soil fertility there are no significant improvements except in pH, Ca and Mg. The improvement

in the water quality appears to be mainly caused by indirect fertilization due to disintegrating organic debris and humic material from the forests and high amounts of fertilisers used in the coffee plantations of Chickamagalur district as well as surrounding fields in Hassan, Mandya and Mysore. Here due to moderate rains (50-100 cm) nutrients are not washed off through overflows as in Malnad areas, but tend to be deposited in the tanks themselves or brought down from one tank to the other during moderate surplus flows.

Biotal Studies:

Weeds: Weeds as in western part of Shimoga are found in almost all tanks of the zone in eastern Shimoga, and Chickamagalur districts. The luxuriance of weeds decreases considerably in Hassan, Mandya and Mysore where some of the richest tanks are found. Majority of the tanks can be exploited as they are not choked, emergent weeds being confined to margins. There is a similarity of weeds between canal-fed Shimoga and Mandya tanks, but Cyperus and Graminae grasses are however absent in Mandya tanks. The large Sulekere in Maddur has a rich Nelumbium growth which affects fishing operations. Floating vegetation is not found in Hassan district. Mostly Chara, Naias, Vallisneria, Typha and Jussiaea are found in Mysore district tanks, but these are confined to shallower margins or littoral regions.

Littoral and Bottom Fauna: No significant differences were noted in the invertebrate fauna of the littoral and bottom zones of the tanks in this zone, almost all the listed forms occurring in one or the other tanks. Good insect life is found as vegetation is sufficiently high.

Plankton : The richer trends in water quality are reflected in plankton counts (table 7). Myxophyceae and Bacillariophyceae indicate very rich values surpassing all other zones, but with few desmids. Increased Myxophyceae is mainly due to blooms of Microcystis in some tanks following fertilization, especially in Chickmagalur, Hassan and Mysore tanks. Protozoans and rotifers were lower in numbers in the zone than in Malnad tanks, cladocerans being also lower than in Maidan tanks. Considering all factors, plankton counts are as good as the rich

Black Cotton zone tanks, phytoplankton dominating from 2 to 8.1 over zooplankton. Hassan district tanks that showed higher alkaline values, revealed qualitatively richer phytoplankton growth. Diatoms of as much as 1,136 units per litre were found in certain tanks of Mandya district (Yeliyur tank). Average total plankton per litre in all tanks was 1,808 units per litre, 1,616 and 92 units being the values of phyto and zooplankton groups.

Black Soil Zone:

Soil and Water Quality:

Bidar, Gulbarga and Bijapur almost wholly come under Black Soil zone; Raichur, eastern Dharwar, and Chitradurga are considered under this zone, as they have mainly either a mixed black and red soil or only black soil. The 'regur' type of black soil is derived from rocks containing soda lime felspars, produced under impeded drainage conditions. Elevated areas have red soils and lower areas black soils. Black soil has a high clay content and is not porous, with high water holding capacity. Soil swells when wetted, but develops cracks on drying. Though sticky while wet, during rains this soil turns into quagmires of heavy clay. A high proportion of alumina, lime, magnesia and potash characterise its composition. It is rich in humus (1 to 10%), and small nodules of Kankur(Calcium carbonate). Black soil is very fertile and has a high base status and high base exchange capacity. High P_2O_5 and K_2O factors are found in it. It is alkaline in reaction unlike the Malnad lateritic soil and inorganic chemical compounds can accumulate as there is little chance of extensive leaching. High temperatures prevailing in the districts favour disintegration of organic matter in the mud, and because of rich lime content, pH is always maintained towards the alkaline side. pH — 7.7 - 8.0, calcium — 3,533 - 5,100 lbs/acre, magnesium — low to moderate, nitrate - low, ammonia — moderate to high and specific conductivity — 130 - 357 x 10^{-6} mhos characterise this soil. (Bidar district showed lower values in some parts where lateritic soil is found). Water quality in general is quite rich, pH — 7.8 - 9.0, alkalinity — 108-263 ppm, hardness — 52-97 ppm and specific conductivity — 297-1,197 x 10^{-6} mhos. These waters are highly suitable for fish culture if only phosphorus content were slightly higher.

Biotal studies:

Weeds: Being limited in numbers and lacking interconnections tanks generally show wide variations in water weeds found in moderation in this zone. Mostly submerged and emergent leafy vegetation (Hydrilla, Chara and Nitella) or a filamentous rather than spatulate type, are found in almost all districts. Varieties are fewer than in preceding two zones. Vallisneria, Typha, Cyperus, Scirpus etc., are found in Raichur tanks. Restricted distribution of Ceratophyllum in Gulbarga, Potomogeton in Bijapur and Belgaum and Apcnogeton in Bidar districts were noted. Nelumbium, Nymphaea and Ipomea characterise Belgaum, whereas Lymnanthemum, Ipomea and Eichhornia characterise Gulbarga tanks. Overgrowth of vegetation is not a major problem requiring eradication in this zone as weeds do not impede fishing operations. Few tanks exhibited swampy conditions, except in Dharwar and Chitradurga districts where Typha, Scirpus, Cyperus etc., were found.

Littoral and Bottom Fauna: No significant differences in the distributional trends of littoral and bottom invertebrate fauna were noticeable from the preceding zones. Rich chironomid population, however, was noted in tanks containing generally a mucky bottom especially in Gulbarga and Bijapur. Tubifex were also similarly distributed. Culicidae were found mostly in tanks of Chitradurga district. In intensity of distribution, aquatic insects were only moderately distributed unlike in the earlier three zones, as vegetation cover is considerably less.

Plankton: In density and specificity, tanks in this zone, are more or less similar to the Transitional zone tanks, but with higher zooplankton concentrations, ratio between zoo- and phytoplankton being 1:3. Myxophyceae dominate, Anabaena, Microcystis and Phormidium having shown blooms in some tanks. Blooms of Pinnularia in Chitradurga district inflate plankton counts. Desmids in general were fairly represented in Bidar, Chitradurga and Dharwar tanks. Chlorophyceae dominated (almost entirely by Hormidium) in Bidar district, Pediastrum in Bijapur and Spirogyra in Chitradurga. Amongst zooplankton, Protozoa were represented fairly well, Difflugia, Phacus and Ceratium being dominant variously. Rotifers, cladocerans and copepods were largely encountered as compared to other zones. Keratella and Brachionus amongst rotifers, Daphnia, Diaptomus and Chydorus (Chitradurga) amongst cladocerans and nauplii amongst copepods

contributed to the maximum density. Nature of plankton and their numbers reflect the general richness of tanks in this zone, which is more or less parallel to the Transitional zone.

Blooms of Myxophyceae often noted indicate fertility of the tanks and availability of free phosphorus in the water. Good number of cladocerans reveal that water quality also is good, there being no excessive manurial action. The rich plankton of the tanks in this zone, coupled with the soil and water quality, indicate that tanks in this zone can be highly productive. Average values are - phytoplankton 707, zooplankton 254 units per litre.

Red Soil Zone:

Soil and warer quality:

In the districts covered by this zone; i.e. Bellary, Tumkur, Kolar, Bangalore, parts of Mysore, Mandya, fringes of Hassan, Chitradurga and Dharwar as well as whole of Coorg, red loams or 'tropical red earths' cover nearly 21,500 sq. miles (55,663 sq. Km). These soils are derived principally from granites and gneisses. They are light in texture, porous and friable, as well as plastic, but generally are devoid of lime Kankar (concretions) and are free from carbonates. Texture may vary from gravelly to sandy or clayey loam. On account of loose yellow kaolanite decomposed rock ('murram'), drainage is easily facilitated, and hence water holding capacity is very low. These soils are usually neutral in reaction, but tend to develop acidity. pH values of 8.0 are also not uncommon. Red soils are poor in organic matters (humus), nitrogen and available P_2O_5, but possess moderate amounts of potash. Iron oxides are found in a diffused condition or in concretions. High amounts of artificial and bulky manuring is required to make these soils productive for crops. Red sandy loams are found in parts of this zone, and are characterised by shallow, gravely red soils. Base status of all red soils is low.

Samples of soil show slightly alkaline or neutral pH (Kolar 6.1, while others 7.0-7.7). Available calcium and phosphorus indicate only moderate values (very poor in Bangalore district). Magnesium showed low to moderate and nitrogen (as ammonia) rich values similar to black soils. Reasons for this high

nitrogen is again due to artificial manuring of soils, which on moderate leaching helps these manures to enter tanks. High temperatures and lower rainfall further serve to maintain the nitrogen complex in the tanks' surface soils. Since most tanks are seasonal, the salts and nitrogen are recovered from the soil to the water over and over again. Fairly good calcium maintains the observed alkaline pH in many of the tanks. In water, average ranges of pH-6.8 to 8.3, alkalinity - 61-125 ppm, hardness - 58-88 ppm and specific conductivity --185-474 x 10^{-6} mhos in four typical districts, are poorer in values while compared to black and transitional zone soils. Low concentrations of phosphorus and calcium in acidic medium, act unfavourably towards plankton growth; even under bright sunlight, photosynthetic activity would not shift carbonate - bicarbonate equilibrium to the alkaline pH. On the whole, tanks over red soils are poor plankton producers as compared to black and transitional zone tanks. Tanks situated in calcium poor soils appear to inhibit growth of bottom organisms, like molluscs, as their intensity is very poor in most of the tanks examined.

Biotal Studies:

Weeds: In the variety of weeds, tanks in red soils show great contrasts even though majority of weeds listed are found in one or the other tank. Most tanks being seasonal, showed only littoral vegetation, which is activated year after year after a period of quiescence in summer.

Perennial weed infestation is found in smaller 'Gokattes'. Mainly submerged vegetation (Hydrilla, Chara, Potomogeton, Aponogeton) dominated over emergent, littoral vegetation (Jussiaea, Polygonum etc.) in Tumkur tanks. Pistia and Lymnanthemum were noted in Tiptur tank . More or less similar conditions prevail in tanks in Bangalore district, where Typha, Marsillia, Ipomea are found in addition. Perennial Kolar tanks have Hydrilla, Aponogeton, Jussiaea, Typha, Ipomea, Marsilla etc., all towards littoral areas. Only under exceptional conditions tanks in this zone showed weed infestation, which is restricted to Eichhornia in some tanks fed by sewage and other organic matters, or to submerged vegetation like Chara, Hydrilla or Ceratophyllum. Except for a few tanks, choking by weeds is not a major problem in the districts of this zone affecting either fish culture or exploitation. Most seasonal tanks in this zone remain turbid for long periods due to absence of aquatic weeds, which otherwise serve to lower turbidity.

Littoral and Bottom Fauna: Only moderate littoral and bottom fauna density is noticed in this zone. Almost all representative forms of water insects and gastropodan molluscs are found. Tanks with sparse vegetation do not indicate a good insect fauna. Ephemeroptera (Baetidae), Odonata (Zygoptera), Coridixae are well represented. Tubificids are also well represented, Tubifex being common, but Chaetogaster and Stylaria are restricted to sewage fed Bellandur and similar tanks. Seasonal tanks however showed very poor bottom fauna, except just one or two species of small insects in abundance (Corixa, Notonecta etc.).

Plankton: Ratio of zoo- to phytoplankton is highly variable, in Bellary being 1:2. Myxophyceae dominated in Bangalore district, Bacillariophyceae (Navicula, Fragillaria, Cymbella) in Bangalore and Kolar tanks. Tumkur tanks are the poorest in all groups of phytoplankton, but indicated a rich zooplankton (copepods and rotifers dominating). Tanks in Bangalore district are also quite rich in plankton. Myxophyceae (Microcystis, Anabaena) dominated closely followed by diatoms (Navicula), copepods, protozoans, ritifers and cladocerans were found to be rich. Probably, these rich concentrations in Bangalore and Tumkur are due to the intense manuring of fields surrounding the tanks. Majority of tanks in Kolar and Bellary districts are not very dense in plankton. But the seasonal tanks found in large numbers possess usually high zooplankton concentrations. Plankton complex in the zone, is however poor compared to tanks in black and transitional zone soils, and conforms to the pattern of the chemistry of soils and water mentioned. Average plankton counts recorded are 847 per litre of which 734 is constituted by phyto- and 113 by zooplankton.

Remarks:

In general, it is found that index of production of plankton and other biota (inclusive of weeds) is a pointer to the combined fertility of the soil and water. The transitional zone and black Soil zone tanks possess the highest productive tanks, with the Red Soil zone coming next. Malnad tanks are rich with an abundance of weeds and indicated that they too are not bare of fish food organisms, as the weeds themselves can offer directly or indirectly sufficient food to various types of fishes.

Microcystis and other members of Myxophyceae whenever they occur are usually in blooms, and account for the higher counts of phytoplankton. Hence the dominance of Myxophyceae in a tank is only an indication of the richly available phosphate in the water which can contribute towards a greater abundance of micro-organisms of value. Microcystis by itself does not form fish food even if found in high density butthe associated protozoans and entomostraca, any Chlorophyceae and diatoms actually form the available fish food; wherever high fertilisation by indirect means has preceded, Myxophyceae have occurred in higher density in samples. In Malnad and Coastal zone tanks, desmids and protozoans dominated. This is perhaps due to the disintegrating organic (vegetable) matter resulting in an acidic pH of water, which is not a congenial medium for growth of entomostracans, especially cladocerans, whichare hence absent. Cladocerans also do not thrive in waters containing ammonia especially under critical oxygen levels. But in tanks showing slight signs of pollution (e.g. fortmoat tanks, or some sewage fed tanks), the desired levels of oxygen are well maintained, and hence, even in presence of ammonia, cladocerans have thrived. Rotifers on the other hand, have no limitations, and are found generally in all zones. Association of protozoans and rotifers with Myxophyceae are indicative of a high degree of fertilisation verging on pollution in tanks. Ceratium amongst Protozoa appears to exhibit a preference to alkaline and clear waters.

Weed infested tanks are generally deficient in plankton growth as the rooted weeds utilise all available phosphates in the water, depriving plankton of their essential nutrients. Where floating vegetation (Eichhornia, Pistia, Lemna, Wolffia) flourish with Myxophyceae bloom as in some village and temple ponds, phosphate is constantly made available to the water by degeneration of Microcystis allowing no rooted plants to grow. These floating plants serve to remove the phosphate.

Microcystis blooms also check penetration of light and deprive the bottom of oxygen, which also hinders colonisation of submerged higher aquatic plants. Silica in tanks when present even in quantity, is not made use of by diatoms if other groups supplant them in density, but only if groups such as Microcystis die out for causes like lower temperatures etc., diatoms can

multiply as observed in Bellandur tanks during detailed studies. Temperatures ranging between 22°-30°C and alkalinity ranges of 80 to 130 ppm appear to offer optimum conditions which make tanks in Black soil and Transitory zones highly productive in diatoms.

In seasonal tanks of Karnataka zooplankters are observed to be on the increase from December, reaching a peak in April-May when tanks usually dry up. Initially on first filling of a tank in early monsoon rains, a zooplankton growth results as nutrients that go into a kinetic state in the substrate after the process of earlier drying up, are released. The nutrients are redissolved, the water remaining productive for plankton growth right from the beginning. Decay of any terrestrial vegetation that might have temperarily invaded the tank bed during the exposure period, also provides nutrients to the water on filling up. Shallow nature of seasonal tanks, influence of readily attainable high temperatures due to shallowness, disintegration and mineralisation of salts and organic matters during exposure, as well as additions of further humic matter during grazing of cattle, render the seasonal as well as perennial tanks quite productive of plankton. Such conditions remain stable for the duration of water stagnancy in tanks free from excessive weeds.

Perennial tanks in Karnataka show only mild or no signs of eutrophication (e.g. mucky bottom, lack of bottom organisms etc.) within the prevailing depths and light penetration. But in several tank types that do show high levels of organic depositions (Bijapur, Bidar and Gulbarga district tanks and Bellandur tank near Bangalore), critical levels of ammonia, oxygen etc., are not generally reached. Only in mineralisation processes of bottom ooze, some draw backs are noted, but the bacterially active bottom (exemplified by high protozoan counts), still offers enough scope for fish culture. As most fishes like Cyprinus carpio, Cirrhina spp., all Labeo spp., many Puntius spp., are mainly detritus feeders, actual counts of plankton in water, do not indicate their value as direct fish food, but only as 'detritus' producers. These fishes do not directly feed on plankton as juveniles or adults, but mainly on detritus that settle to the bottom and 'blooms' and pulses of intense plankton production, provide a major supply of fine detritus. Tanks especially in Malnad and Transitory zones that exhibit a high degree of vegetative growth, even in the absence of high plankton counts hence

possess abundant fish food. The microscopic organic debris produced by vegetation in the absence of living plankton, can contribute in no small measure sufficient food to detritus feeding fishes. Presence of abundant protozoans that feed on detritus and bacteria in these tanks, appears to support this conclusion. Apparantly while water quality and plankton do not show rich indices of productivity, still the tanks containing too many weeds may be highly productive, as many fish at least all carps and catfishes like Pangasius possess alternats feeding habits.

From the observations now made in Karnataka, and elsewhere it seems that pH of above 7.5, alkalinity values between 80 and 200 ppm (methyl orange alkalinity), bicarbonats hardness rather than carbonats hardness, conductivity values of between 200 and 500 x 10^{-6} mhos, a phosphorus value of 0.05 and above and an alkaline soil with humus, are to be considered suitable for fish cultivation (Nitrate indicated in soil and water is subjected to various cahnges and may not always indicate fertility of a tank). Manipulating the waters and soil slightly to bring about the desired minor changes is easy by manuring or liming.

Initial flushings of rain water in Karnataka tanks dilute the chemical constituents (Nutrients) as also reduce the density of zooplankton in particular which would have earlier become concentrated in summer due to evaporation. With seepage of water through the soil mantle, the minerally enriched subsurface waters are later drained into these tanks. The nutrients are suspended through the period of turbidity; since turbidity reduced penetration of light essential for photosynthetic activity, phytoplankton production is adversely affected, even though nutrients may be high. With a decline in turbidity, nutrients are more easily utilised by the growing plankton. As the rate of multiplication of zooplankton is slow, phytoplankters multiply rapidly and hence zooplankton peak succeeds phytoplankton in such tanks. It is also established that zooplankton density is determinated by the richness of phytoplankton population. Zooplankton dominates as zooplankton in such tanks can feed on particulate organic matter produced by constantly decomposing aquatic weeds.

Decomposition of weeds may also impart acidity to the soil even though water is alkaline, with alkaline deposits surrounding the tank (Huchammankere near Bangalore). In such a medium, phosphorus is not released into the water unless pH is shifted to alkaline side, a process that can be induced by addition of lime. Besides, iron remains in a ferric state in the presence of considerable dissilved oxygen contributed by weeds during photosynthetic activity. This also withholds combined phosphorus from being released to the water. Only when ferric iron is reduced to ferrous iron, phosphorus becomes available to the water. However, poor the phosphorus content may be in water, diatoms store it to the maximum and with available silica, become abundant in weedy tanks. Diatoms are found mainly as settled coating, on vegetation (35,000 to 38,000 units or more in 100 gms of leafy vegetation).

Turbidity combined with rich mineral and trace elements suspension, induces better productivity potential than tanks where turbidity is due purely to silt suspension caused by physical means.

The weedy tanks shelter good molluscan life, which thrives on minute settled detritus and organisms; they also harbour chironomids and other insect groups. Organically rich tanks (indicated by presence of ammonia) hence show a higher density of these organisms.

A direct relationship between chironomid larvae and iron is also observed (Narayanaghatta tanks near Bangalore), where with increased iron content, chironomids accounted for 90-95% of the total bottom organisms.

Rise in temperature accelearates photosynthetic activity and carbon-di-oxide required is supplied by breaking up of bicarbonate ion which lowers alkalinity values. As such an inverse relation between temperature and alkalinity is noticed in weedy tanks.

Marginal and submerged weeds if present in some quantity and non-interfering in fishing operations are greatly helpful, as they not only offer shelter, protection and food to fish and young fish but also to fish food organisms like aquatic insects and their developing stages.

FISH AND FISHERIES

However high the productive potentiality of a tank for production of fish food organisms, considering the basic chemical factors, ultimate results will be determined by the available species of fish exhibiting various food habits as also fishery management practices affecting such tanks. The following findings as to fishes of tanks in Mysore and factors influencing their growth, survival and exploitation were noted.

Tank Fishes of Karnataka

Tank fishes in Mysore State are numerous, uniform in genera /are in all districts and/confined mostly to medium and small sized species. Several river drainages in the State as shown in sketch map determine largely the available forms, as the tanks within the catchement of a particular river, are apt to show almost similar species. In table 8, the several species recorded in tanks and their distribution are noted. The following genera and species form the bulk of the catches. River fishes occasionally found in tanks are not generally included though in Karanataka, over 150 species are recorded from the several river systems.

Large species (above 500 mm and 2 Kg. in wt.)	Medium sized species (200 -500 mm and 1/2 to 1 Kg in wt.)	Small sized species (below 200 mm and weighing up to 200 g.)
1	2	3
*Catla catla (Ham.)	Notopterus notopterus (Pallas)	Oxygaster (3-4 species)
*Cirrhina mrigala (Ham.)	Cirrhina fulungee (Sykes)	Esomus barbatus (Jerdon)
*Labeo calbasu (Ham.)	Cirrhina reba (Ham.)	Rasbora (2 species)
Labeo fimbriatus (Ham.)	Labeo ariza (Ham.)	Amblypharyngodon (2species)
*Cyprinus carpio (Linn.)	Labeo boggut (Sykes)	Puntius amphibius (Cuv. & Val.)
*Labeo rohita (Ham.)	Puntius sarana (Ham.)	Puntius chola (Ham.)

1	2	3
Wallago attu (Bl. & Schn.)	Ompok bimaculatus(Bl.)	Puntius dorsalis(Jerdon)
Channa marulius(Ham.)	Ompok pabo (Ham.)	Puntius ticto (Ham.)
Channa leucopunctatus (Sykes)		
Channa striatus (Bl.)	Mystus cavasius (Ham.)	Puntius stigma (Ham.)
	Heteropneustes-fossilis(Bl.)	Mystus vittatus (Bl.)
	Clarias batruchus(Linn.)	
	Channa punctatus (Bl.)	
* Imported and stocked	Channa gachua (Ham.)	
	Rhyncobdella aculeata (Bl.)	
	Mastacembelus armatus (Lacepede)	
	Mastacembelus pancalus(Ham.)	
	Glossogobius giuris (Ham.)	

1. Large species: Though there is a diverse fish fauna in each Karnataka river unlike in any part of India, only the above few forms dominate the tanks. Among the large growing forms, Catla catla, Cirrhina mrigala and Labeo rohita have not yet naturalised in any tank (except for a suspected breeding of L. rohita in Shantisagar tank). These forms along with Cyprinus carpio (Bangkok strain), have contributed substantially to better fish production in the tanks wherever introduced. Labeo calbasu and L. fimbriatus seldom occur naturally except in some reservoir-like tanks. They are found around Arsikere (Hassan dt.) connected tothe Vedavathi through a series oftanks below as also in Vishnusamudra in Chickamagalur district. Major quantity of fish from Vanivilas Sagar reservoir is constituted by these two forms with Puntius kolus. Puntius carnaticus is an established fishery in Mugunahalli and Bannur tanks owing to canal connections with the Cauvery. Tanks at Channarayapatna and Dindiganur in Hassan dt., are recently stocked with P.carnaticus and Tor spp. fingerlings from the Hemavathi river but their responses are yet to be known. Labeo calbasu being distributed in both the Krishna and the Cauvery drainages, occurs in tanks connected with the canal system taking off from the two rivers or their tributaries, and is recorded with L. fimbriatusand Puntius pulchellus in Hutchurayankere in Shimoga.

TABLE 8

List of fishes recorded in tanks of Mysore

Sl. No.	Species	Local Name	Approximate Max. size (mm.)	River Catchment	District/Taluk/ Tank	Whether Main/Subsidiary/Stray	REMARKS
1	2	3	4	5	6	7	8
1.	Notopterus notopterus (Pallas)	Volagutha-tte	600	All River Catchments	Almost all districts and in all large perennial tanks.	Subsidiary	Uneconomical except when occuring in large numbers. Recorded in tanks and those connected with river canals; predaceous.
2.	Chela atpar (Ham.)		80	-do-	-do-	Stray	Both species occur mixed with minnows in most tanks. Being too small, are uneconomical.
3.	Chela laubuca (Ham.)		70				
4.	Oxygaster argentea (Day)		100	-do-	-do-	Subsidiary	These forms occur in tanks but are frequent in tanks connected by canals or drains to rivers. In seasonal tanks they are destroyed. These species supplement other 'weed' fishes of tanks.
5.	Oxygaster clupeoides (Bl.)		100				
6.	Oxygaster phulo (Ham.)		150	-do-	-do-	-do-	
7.	Barilius barila (Ham.)		100	All River Catchments except Palar	Tanks connected to rivers by canals	Stray	Presence of these forms in tanks is through canals from weirs, headworks and dams, as they are carried into tanks by the canals. But in some Malnad tanks fed by hill streams are found naturally. Uneconomical.
8.	Barilius bendelisis (Ham.)		150	-do-	-do-		
9.	Barilius gatensis (Cuv. & Val.)		150	-do-	-do-	-do-	
10.	Danio (Brachydanio) rerio (Ham.)		25	-do-			
11.	Danio (Danio) aequipinnatus (Mc. Cl.)		60	-do-			

Contd... Table - 8

1	2	3	4	5	6	7	8
12.	Esomus barbatus (Jesion)		90	All Catchments	Tank throughout all the districts.	Subsidiary	These three forms are the hardy tank fishes, found naturally, one or more species contributing substantially to total catches, especially in seasonal tanks.
13.	Rasbora daniconius (Ham.)	Sasalu	180	-do-			
14.	Rasbora rasbora (Ham.)	Sasalu	125	-do-			
15.	Amblypharyngodon melittinus(Cuv.& Val.)	Inapupa-kke	75	-do-	In most tanks in all districts	-do-	One or both species may be found; when found, contribute to the generl 'minnow' catches considerably.
16.	Amblypharyngodon mola (Ham.)	Iliyambu	75	-do-		-do-	
17.	Aspidoparia morar (Ham.)		130	Restricted to the Krishna	Most Northern and Central district tanks	Stray	Restricted to tanks connected with rivers, but occurs,,naturally in large tanks like Shanthi Sagar, Madag, etc.,.
18.	Catla catla (Ham.)	Katla	1,500	Propagated	Selected for tanks	Main & Subsidiary	Successfully stocked and growrn in almost all districts in selected tanks. Has not established however in any tank except a Reservoir (Vanivilassagar); Cultivated.
19.	Cirrhina fulungee (Sykes)	Arja	220	Krishna	Tanks in Northern and Central District	Subsidiary & Stray	Being a river form, its presence in tanks is due mainly to connections with the streams of the river system.
20.	Cirrhina mrigala(Ham.)	Mrigala	900	Propagated	Selected tanks	Main & Subsidiary	Successfully stocked and cultivated. Has not established in any tank.
21.	Cirrhina reba (Ham.)	Thari	200	Krishna, Godavary & Cauvery	Tanks in most districts.	Subsidiary & Stray	Occurs in considerable numbers in tanks connected with rivers concerned. Grows fast and in some seasonal tanks, adds to the general catches.
22.	Garra spp.	Kallu Korava, Kallu Molaga, Kallu Moggu, Mukharthi	100-250	Catchments except pala	Canal connected tanks or large reservoir like tanks	Stray	Presence of one of the three species i.e. G. jerdoni, G. mollya or G.stenorhynchus in a tank is abnormal; these species are rocky hill stream forms. They are sometimes round in running waters below large tanks (Shantisagar, large Mandya tanks etc.)

Contd... Table. 8

1	2	3	4	5	6	7	8
23.	Labeo ariza (Ham.)	Thama	200	Godavary, Krishna & Cauvery	Occurs variously in one or the other tank in all districts	Subsidiary & Stray	These forms occur in a consistent manner only in large reservoir like tanks; in canal connected tanks they are carried from the rivers, and grow quite well; Economically important.
24.	Labeo bata (Ham.)	Chigara	250	-do-			
25.	Labeo boggut (Sykes)		180				
26.	Labeo calbasu (Ham.)	Kammachalu Machalu	500	All catch-ments			
27.	Labeo fimbriatus (Bl.)	Kemmenu Machalu	500	Krishna & Godavary		Main & Subsidiary	The species has naturalised in large tanks in Shimoga (Shantisagar, Madag), Chickmagalur (Vishnu samudra) and Hassan (Arisekere) districts. It does not move into tanks from rivers. Economically important in tanks.
28.	Labeo rohita (Ham.)	Rohu	800	Propagated	Selected tanks in almost all districts.	Main & Subsidiary	Successfully stocked and cultivated with Catla catla and Cirrhinia mrigala in selected tanks.
29.	Oreichthys cosuatus (Ham.)		35	Krishna	Malnad tanks	Stray	Unimportant
30.	Puntius amphibius (Cuv. & Val.)	Pakke	80	All Catchments	Almost in every district in one or other tank	Subsidiary	Adds to the general economy of tanks whenever found.
31.	Puntinus carnaticus (Jerdon)	Gande	550	Cauvery	Recorded in Mugunahalli tank in Mysore district and tanks in Mandya	Subsidiary	Enters canal connected tanks form the Cauvery and the Hemavathy irrigational system. Appears to have been stocked in tanks in Hassan District (Chennaraya patna, Dindiganur).
32.	Puntius chola (Ham.)	Pakke	120	All Catchments	Tanks in every district	Main & Subsidiary	These are the "minnow" carps; contribute substantially in almost all tanks to the small sized fish groups that occur in large numbers. P. dorsalis forms in exclusive fishery in Bellandur tank, wh er it also grows to the size indicated.
33.	Puntius conchonius (Ham.)	Pakke	75				

Contd.. Table .. 8

1	2	3	4	5	6	7	8
34.	Puntius dorsalis(Jerdon) P. puckelli (Day)	Warupakke	160	Cauvery and Krishna	Tanks in Bangalore, Tumkur, Chitradurga and Raichur Dist.	Main & Subsidiary	
35.	Puntius filamentosus (Cuv. & Val.)	Karse	220	Krishna, Cauvery	Tanks in most Westernghat	Stray	Unimportant
36.	Puntius pulchellus (Day)	Haragi	600	Tungabhadra	Shimoga Dist.	Subsidiary	Young carried through canals into some tanks, appear to grow well as they add to the general catches occasionally.
37.	Puntius kolus (Sykes)	Kolasa	300	Godavary & Krishnia	Bijapur (Bhuthnal tank)	Stray	-do-
38.	Puntius sarana (Ham.)	Gende Gendu	250	All Catchments	In almost every tank of all districts	Main & Subsidiary	P. sarana is the largest naturally occurring tank species; when available, being of larger size greatly contributes to the general yield. Other two species being minow carps, supplement the general catch, occurring in larger numbers. Economical tank species.
39.	Puntius stigma (Day)	Pakke	85	-do-	-do-	-do-	
40.	Puntius ticto puntius(Ham.)	Pakke	80	-do-	-do-	-do-	
41.	Tor spp. (Mahseers)	Bili Meenu	1,500	Krishna & Cauvery	Tank connected by canals	Stray	The Mahseers enter some tanks through canals and attain good sizes. Cultivation as such is not practised. The two forms that occur in Karnataka i.e. T. mussullah and T.khudree, can be useful in selected tanks (Predaceous)
42.	Lepidocephalus guntea (Ham.)	Nalli	80	Godavary, Krishna, Sharavathy.	In alltanks and district concerned	Subsidiary & Stray	The forms occur sometimes in economical numbers in tanks while drying up.
43.	Lepidocephalus thermalis (Cuv. & Val.)	Oudimeenu	80	Cauvery & Palar			
44.	Nemachilus sp.	Kellunalli	70	All catchments	In most tanks	Stray	Mainly stream forms: occasionally encountered in general catches.

Contd... Table-8

1	2	3	4	5	6	7	8
45.	Ompok bimaculatus (Bl.)	Domme, Godle	300	-do-	In most tanks in all districts	Subsidiary	Recorded mostly in weedy medium and larg tanks O. bimaculatus is morecommon. Predaceous; in some tanks the forms con- tributed to a sustained yield, and are t be considered as natural tothe tanks.
46.	Ompok pabo (Ham.)		340	-do-			
47.	Wallago attu (Bl. & (Schn.)	Bale, Padu	1600	-do-	In most large tanks	-do-	Occurs in canal fed tanks and larger old tanks like Shantisagar, Madaga, etc. wher due to riverine conditions, the species multiplies year after year; found in most Malnad tanks. Highly predaceous.
48.	Mystus cavasius (Ham.)	Meesegirlu	250	-do-	In most tanks	Subsidiary & Stray	Recorded in most tanks, adding to the total yield.
49.	Mystus seenghala (Sykes)	Helathi	400	Krishna	Bhuthnal tank	Stray	Species occurs in tanks connected to rivers occasionally; predaceous
50.	Mystus vittatus (Bl.)	Girlu	110	All catchements	In almost every tank	Main & Subsidiary	This small catfish is common in all perenn and most seasonal tanks; tank fish of importance, but predacelous.
51.	Heteropneustes fossilis (Bl.)	Chelu meenu	280	-do-	All tanks	Main & Subsidiary	These three forms consist the major 'wild' species of fish in tanks. Weed infested and Malnad tanks usually sustain a good fishery ofthe species; predaceous, and invade seasonal tanks from perennial water
52.	Clarias batrachus (Linn.)	Anemeenumarve	350	-do-	-do-	-do-	
53.	Clarius dussumeiri dussumeiri Val.	Chelumeenu	350	Krishna	Belgaum, Dharwar, & Shimoga	Stray	
54.	Gambusia affinis (Baird & Girard)		70	Southern Karnataka	Bangalore, Mysore & Shimoga	Subsidiary	Many tanks now hold marketable quantities this exotic form first introduced in Karnat as a larvicidal form
55.	Oryzias melanostigma (Mc.Cl.)		60	All Catchments	Mostly in pere- nnial tanks	Stray	Not of economical value except as larvici fishes.
56.	Panchax lineatus (Val.)		76	-do-	-do-	-do-	

Contd.. Table- 8

1	2	3	4	5	6	7	8
57.	Channa gachua (Ham.)	Holekorava	210		In all perennial and seasonal tanks	Main, subsidiary and stray	These 'Murrels' are the most important tank fishes and with Heteropneustes, Clarias and minnow carps, form the bulk of the yield from most tanks. These forms are preferred in all interior districts to other fishes; should be eliminated from tanks stocked with other forms being highly predatory.
58.	Channa leucopunctatus (Sykes)	Hoovumeenu	800				
59.	Channa marulius (Ham.)	-do-	500	All Catchments	In all perennial and seasonal tanks	Main, subsidiary & stray	-do-
60.	Channa striatus (Bl.)	Kachumeenu	500	-do-	-do-	-do-	
61.	Channa punctatus(Bl.)	Korava	300	-do-	-do-	-do-	
62.	Ambassis nama (Ham.)		75	-do-	In many tanks of districts	Stray	Uneconomical
63.	Ambassis ranga (Ham.)		100	-do-			
64.	Macropodus cupanus (Cuv. & Val.)		50	Tunga-bhadra	Shimoga Dist.	-do-	Too small, uneconomical
65.	Glossogobius giuris (Ham.)		220	All catchments	In all Districts	Subsidiary & Stray	Adds to tank yields; highly predaceous; introduced in the Cauvery catchement with the major Gangetic fry.

Contd... Table. 8

1	2	3	4	5	6	7	8
66.	Macrognathus aculeatus (Bl.)	Havumeenu Hanchumeenu	100 500 200	All catchments	In all districts	Subsidiary	These 'spring eels' greatly add to the value of tank species especially in perennial tanks.
67.	Mastocembelus armatus (Lac.)						
68.	Mastocembelus pancalus (Ham.)						
C.	Transplanted spp.						
1.	Cyprinus carpio (Lin)	Known by their generic name		Exotic form	Stocked in several tanks	Subsidiary	These forms have been introduced with varying degrees of success; C. carpio adds to the general tank catches where introduced; Mugil corsula has naturalised in Markandeya reservoir, having been introduced unwittingly with major Gangetic carps from Calcutta. Tilapia, and Chanos are grown in Coastal tanks. Etroplus and Osphronemus gorami are stocked in some fish farms, and some small tanks. None of them have so far given spectacular results as the major Gangetic carps, except for C. carpio.
2.	Mugil corsula (Ham.)						
3.	Tilapia tilapia						
4.	Etroplus suratensis (Bl.)						
5.	Osphronemus gorami (Lacep)						
6.	Chanos chanos (Forskal)			Collected from the sea			

L. fimbriatus is found also naturally in some Bijapur tanks (e.g. Bhutnal) where also L. calbasu, Tor spp., Puntius kolus, Mystus seenghala from the Bhima ascend as young through the waste weir flows.

Similarly Wallago attu though a larger form, does not occur except in canal fed tanks, which it enters as young from the rivers during monsoon months. Only large tanks in Karnataka hold a self-sustaining stock of Wallago attu (Shantisagar, Madag, Mandya tanks etc.).

Presence of other large-growing river fishes e.g. Labeo potail, L. kontius, Puntius dubius, P. dobsonii, Tor spp., M. aor., Bagarius bagarius, etc., in tanks is fortuitous. Channa marulius, C. leucopunctatus and C. striatus are perhaps the most important indigenous tank fishes in Karnataka. In perennial weedy tanks they occur consistently year after year, even though their capture is restricted to only a few individuals at any time, depending upon the limited fishing methods adopted. In seasonal tanks however, these 'murrels' occur in uneconomical sizes at the time of drying. In summer months, when perennial tanks shrink, catches of upto 75% is usually made up of murrels by weight. As more effective dragnets are operated, their supplies to towns and cities during summer increase in quantity.

ii. Medium sized species: About 15 medium sized species account from 15 to 20% of total catches in tanks; in some individual forms like Notopterus notopterus, P. sarana, Ompok spp., Clarias spp., Channa spp., Mastacembelus spp., may dominate at times, though not consistently. Only a few forms occur in any one tank amongst this group, and their removal is variable from season to season and year to year, depending upon various ecological factors, Labeo ariza, L. boggut, C. reba and C. fulunges occur in some large tanks with regularity because during even minor floods they can spawn in the vicinity of such tanks (e.g. Arsikere Tank, Thimmappan yaka-nakere in Hassan, Tayalur, Nidige). Ompok and Notopterus generally occur in weedy tanks, where they thrive with murrels and Clarias, feeding upon the abundant minnows (e.g. Bethamangala, Madag, Sulekere). Arsikere, Ginigera and Daroji tanks show mainly Ompok sp. Puntius sarana is perhaps the commonest medium sized tank fish in tanks and occurs in almost all perennial tanks. (P. chrysopoma and P. pinnauratus are referable to P. sarana). This spawns in all large tanks. Clarias batrachus forms bulk of the catches in Malnad tanks and occurs otherwise all over the State, particularly in weed infested muddy bottomed tanks or those which contain forest debris.

Its catches during rainly season in Malnad is reported to be very high when it is said to migrate for breeding. With Clarias, murrel species like Channa punctatus, C. gachua and spiny eels e.g. Rhyncobdella aculeata, Mastacembelus armatus and M. pancalus from economical carches in many perennial tanks. The spiny eels become abundant in some tanks as they breed almost throughout the year and feed extensively upon small minnows. Since all these species are mud dwelling and hide amongst stony crevices along the tank bundh or under submerged weeds, majority of them remain uncaught by methods of fishing now known. Only when tanks are overflooded or shrink in size, they are removed in quantity sporadically. Almost all perennial tanks posses a self-sustained population of these forms as they can spawn in tanks and have established population equilibrium with minnow carps.

iii. Small sized species: The small sized species listed are mostly the 'minor carps' and are designed as 'weed' fishes('trash' fishes) as they are unwanted in any large scale fish cultivation programmes. However, they form perhaps 60-70% of total bulk of fish captured in many seasonal and perennial tanks. The small Puntius spp., and Amblypharyngodon spp., form the bulk of catches in seasonal tanks with an occasional murrel, Clarias or Mystus. P. dorsalis (= P. puckelli) is restricted to tanks around Bangalore, Tumkur, Chitradurga districts and growth being about 150 mm in about 4-5 monthis, is one of the more important forms of tank fishes when it occurs. These forms commonly called "Pudi" meenu, can distribute themselves easily through even very small water connections. Majority of them breed two to three times in the year and reproduce enormously, populating in a short time tanks apparently in free from fish at one time. At the time of drying of a seasonal tank, cartloads of these fish are removed. Even minor rains in April or May, or late in October to December, induce them to spawn within Mysore tanks and within 3-4 months, they become mature, and attain maximum sizes of upto 80-120 mm. They are removed regularly by castnets or small dragnets for local consumption by village fisherman on a subsistence basis. Excess quantity that cannot be consumed fresh, is sundried and sold in the weekly bazars.

Fisheries Management:

Control :

Fishing rights, inclusive of exploitation, stocking and disposal by leasing or licensing of Inland waters (rivers, reservoirs and tanks) rests in Karnataka with the Department of Fisheries. In Dharwar, Belgaumand N. Canara of old Bombay State, the Revenue Department holds fishing disposal rights over a substantial number of tanks. In Kollegal area ceded from Tamil Nadu, Revenue Department credits any amount collected, to the Department of Fisheries. In Coorg, Department of Fisheries undertakes fishing, giving away 50% of the total catch to the local village Panchayats or villagers for protecting fish life. Though originally almost all irrigational tanks and reservoirs were controlled by the P.W.D., the rights of fishing in all 'major' tanks are now vested with the Department of Fisheries, Fishing rights and development of almost all 'minor' tanks are now transferred to the Village Panchayats. Where traditional rights of fishing originally exerted by the Village Panchayats are taken over, some compensation in return for maintenance of tanks is paid by the Department of Fisheries to the Panchayats. As almost all districts are now covered by C.D. Blocks, some of the tanks in 16 Blocks are transferred to the Block Development Officers, who with the aid of Department of Fisheries, stock the tanks with Gangetic major carps or C. carpio and help the village Panchayats to exploit the tanks.

Generally, licences for fishing are issued to the local fishermen by the Department of Fisheries on the basis of gear used, valid for specified areas such as river stretches and perennial tanks. Fishing in almost all seasonal tanks and canal lengths which seasonally are shut down, are generally auctioned, and the highest bidder, whether individuals or village Panchayats or Co-operatives, is given such rights.

There are atleast 34 fishermen co-operative sociaties in inland districts (excluding those in North and South Canara districts on the sea coast). They obtain benefits of subsidised yarn and financial help as well as fish 'seed' for stocking from the Department of Fisheries. Tanks around villages are also leased to them on the basis of average calculated revenues. Though most co-operative societies are ill-managed and indigent, those in Dharwar and Belgaum districts appear to be well organised and contributed substantial quantities of fish to local markets.

A number of tanks are departmentally fished at the time when water starts drying and the fish captured is auctioned or given to a contracter for disposal.

Fishing Methods:

Professional fishermen of the State belong to distinct communities by caste. Exclusively no tank fishermen are found except near larger perennial tanks (Bethamangala, Madag, Shantisagar, Bellandur etc.), as such fishermen also fish the rivers. Professional local fishermen confine their fishing activity to the margins, using no boats, coracles or rafts even nearer large tanks. Only the deep water tribal fishermen - 'Kille- kethas' or 'Burdebesthas' fish reservoirs, deeper tanks and river pools of over 2-3 m depth, using floats. Tamil fishermen from Tamil Nadu, use coracles or rafts when they lease Karnataka tanks. In the case of seasonal tanks, all villagers join in capturing fish at the time of drying, mainly by wading, basket trapping, dagging crudely fashioned nets and hand picking. The following tank fishing methods are in vogue in Karnataka.

Gill nets : Most fishermen near large tanks have recently taken to nylon gill nets of various meshes as they are supplied at subsidised rates by the Department of Fisheries to co-operative societies, development blocks etc. Individual fishermen buy the nylon yearn and braid them as required. The Killekethas move from tank to tank untouched by local fishermen and operating both surface and bottom gill nets, catch substantial quantities of fish. Large tanks in Tumkur, Hassan, Mandya, Chickamagalur and Shimoga are fished mainly by Killekethas when river fishing slackens during monsoon. Weedy, tanks having submerged or minor emergent plants are fished only by these fishermen, individual fishermen releasing nets as he rides the water propelling himself by legs supported by floats (dry 'bottle' gourds of Lagenaria vulgaris) or sealed tins submerged upto his waist. Both surface and bottom nets (of 1/2 m width) are used. Bottom gill nets are not in use except in Shantisagar and Madag tank.

Drag nets: Simple and crude cotton dragnets are used by villagers and fisherman in perennial tanks while shallow, or in seasonal tanks. All these nets are locally braided, and usually are not tanned. These dragnets are used variously as wall nets and filtering nets below waste-weirs or sluices in the vicinity of all tanks at the time of migration of fishes.

Caste nets: Only local communities of professional fishermen are skilled enough to use this 'throw net'. A regular but

small supply of fresh fish to villages and small towns is ensured mainly by cast net fishermen. The nets are radially corded, rounded (up to 3-4 metre in diameter) and effectively used on the margins. Professional fishermen using crude rafts exploit Bellandur tank near Bangalore only by cast nets.

Miscellaneous Nets: Scoop nets also known as 'prawn' nets, with triangularly tied lengths of sticks are used all over the State along the margins of the tanks for collecting small fishes and prawns. These nets are common in southern and central districts. Very little commercial fishing, however, is possible by these nets.

Traps: Both filter traps and sub-conical plunge baskets are found. Plunge baskets are used to capture murrels, Clarias and other mud fishes. Filter traps are used in the inlet and outlet channels from tanks and surplus drains, especially in rainy months in relation to the inflow or outflow of water and migration of fishes. Round baskets with or without aprons are found in Maidan areas, and in parts of Malnad and coastal districts square or rectangular types are observed. During roiling of a tank by community wading, and dewatering, traps and plunge baskets are extensively employed.

Rod and line : Indigenously rigged rod and line with baited hooks are found all over the State with 'throw' lines i.e. baited hooks weighted with sinkers to be thrown some distance in large tanks. Murrels, Wallago attu, Ompok spp., Mastacembelus spp. and on occasions carps, are captured. The practices are crude with regard to materials used and baits.

Poisoning: Though large scale poisoning of tanks is not known, the smaller forest tanks or 'Kuntes' are poisoned by villagers employing locally available poisonous plants. The unripe fruits of Randia dumetorum Lam., locally known as 'Kare, or "Karikare mallu", is extensively used in Malnad areas. Bark seed and root of Barringtonia acutangula (Linn.) known as 'Hole kauva' or 'Neerugangily' growing along streams and swamps are also similarly used. In Bijapur and other northern districts, the latex from various hedge plants especially of Euphorbia thirukalli is similarly used. No chemical poisoning of tanks is known.

Shooting by sight murrels and Wallago in some tanks (Malnad) and dynamiting is known, but not generally employed. Catching fish by baling out water and digging trenches are common while tanks start drying.

DEVELOPMENT AND RELATED PROBLEMS

Aspects requiring attention on existing resources of tanks in Mysore as described are simpler than either riverine or large multiple Project reservoirs. They are far less complicated than the marine fisheries, but in case of management and potential value more important as fish consuming public lives far interior in the villages. Considering that 82,345 ha of perennial stagnant water area in all tanks together is available in Karnataka which even at its minimum presents a stable 48,150 ha, the State has the maximum irrigational tanks water spread in India. This is further controllable for cultivation of fish unlike captural fisheries of the rivers. Adding 2,58,862 acres (1,07,470 ha) of deep reservoirs and at least 1,323 miles (2,130 km) of irrigational canals, the potentialities of controllable inland water resources can now be understood.

Though it may not be possible to attain the normal fish production rates of as high as 500-1,000 kg/ha of fish ponds of other countries (Indonesia, Java, Israel, China etc.) or even of the high production of West Bengal and other N. Eastern States as Karnataka tanks are primarily irrigational in utility, only well planned developmental measures can expect to increase fish production three to four times their present output. The reservoir like tanks listed, and majority of perennial tanks that spread more than 25-30 ha with depths of 1½-2 m and above even during summer, may be intensely cultivated as the draw-downs reduce their areas only 25-30% or even less of maximum spread. A stablised water area of 60-75% of all perennial water sheets is computed to be contained by such tanks. Perennial tanks of just ½ to 25 ha , though high in numbers, do not equal to the larger tanks in total water spread. Heavier drawdowns in small perennial tanks make them ineffectual for fish cultivation. These drawdowns may, however, reduce water to as low as 15-20% of original volume but still water spread area may remain 50-60% of the maximum.

Besides, the numerous village ponds, town and municipal or temple tanks and step wells (or 'Kalyanis'), are not considered here as no data are available. Any comprehensive fish cultivation programme of the tanks in Karnataka requires attention under some of the following items.

Water Resources :

Most of the tanks in Karnataka are subject to water loss by continual drawdowns, heavy seepage, evaporation, etc. during the long dry spells. The canal connected tanks do not possess such handicaps. Underground spring-fed tanks in Malnad and coastal areas, temple, village and town tanks are also stable, being deep excavations reaching water tables. Hence, any fish management programmes in irrigational tanks as long time project are restricted by lowering water levels, and plans can be based on average water spreads only.

i A thorough survey of each stagnant water resource of every taluk on the lines in the proformae (appendices 1 & 2) by the Department of Fisheries familiar with the main biological features, will furnish an authentic record.

ii As far as possible, adjustments in water usage should be made to protect the fishery interests and participation of P.W.D., Revenue and Agricultural authorities is necessary with fisheries development. For instance since most canal fed tanks retain high water levels and are weed choked remaining unfished almost through the year, the P.W.D. and Irrigational authorities may be requested to facilitate fishing by stepping down the supply at the source for short, specified periods when both fishing and manual clearance of weeds can be undertaken.

Seasonal or perennial tanks selected as nurseries or for any semi-natural breeding experiments by 'Major carps, should have an assured supply of water.

i In Karnataka, consumer preference for fish is not rigidly selective as all species of marine, brackish and inland fishes are consumed (fresh or iced) when available. Fresh fish is not available in interior pockets of the State, and if available, the high cost involved, dissuades the villagers from buying the fish. As the fisheries economy and its cultivation is tied up with the village fishermen and towns badly need fish, preference for tank development, should be given priority in areas beneficial to both.

ii Fishes do not fetch locally good market prices and have to be disposed elsewhere from the interior production centres. All the 19 district towns as well as the many industrial centres require constant supplies of fish. Utilisation of tanks close by these consumer centres and facilities for storage and marketing as well as correct appraisal of demand for fish, are needs still to be met in such centres. Some hinterland tanks are regularly supplying fish to these centres (e.g. Kolar Gold Fields, Bangalore, Mysore, Davanagere, Shimoga, Hassan, Tumkur, Dharwar and Hubli), and a series or groups of tanks with regulated fishing and exploitation aided by the Department of Fisheries, will be more utilitarian.

iii The Department of Fisheries should be able to record the market data of landings, supplies, sales, prices, as these are still unknown factors or only vaguely understood. Only then the Department and regulate the fish markets, production and prices.

Fertility of Tanks :

High production of fish depends upon high fertility of tanks and optimal stocking rate. It is already noted that fertility of tanks differs from zone to zone, and is further modified by the presence or absence of weeds and processes of natural fertilisation operating in each zone.

i Both northern Black Soil zone tanks and the Transitional zone tanks do not immediately need any corrective fertility operations. The tanks within these zones contain surplus food organisms for growth of fish, unlike maintenance levels noticed in Malnad, Coastal and Red Soil zonal tanks. Edaphic factors unfavourable to biological productivity may have to be corrected mostly in latter tanks. Low pH (acid) waters as in Malnad and Coastal tanks, great fluctuations in dissolved oxygen levels due to certain plants or algae, toxic effects by decaying plants or algal blooms etc., may unfavourably influence growth, survival, or reproduction of certain species of fishes. Artificial feeding in irrigational tanks to

raise fish crops is not practical proposition due either to the high costs involved, low resources of feed materials and aesthetic considerations; hence resource is to be had almost entirely to natural productive methods that have now emerged, to maintain or raise fish crops.

ii While the larger tanks of 500 acres or so in area (200 ha) cannot be corrected, some smaller ones of less than 25-30 ha in water spread in almost every zone, may be chosen for experimental regeneration of fertility. Liming is indicated in Malnad and coastal tanks and also in some red soil tanks. Fertilisers containing phosphates may be used in tanks found deficient in food organisms and organic detritus.

iii Almost all tanks in Karnataka range between the oligotrophic and eutrophic conditions, exhibiting transparent to green coloured waters, with only moderate amounts of organic deposits on the bottom or suspended in water and always a high oxygen content, aquatic plants (inclusive of phytoplankton) being rich. Basic fertility is moderately high. Since all tanks are shallow, within the prevailing tropical conditions of intense heat both littoral and bottom zones are highly active. No limitations except for certain nutrients, appear to exist utilising the tanks for optimum fish production. In course of years of their existence, these tanks have come to a static level as fish removed means, so much fertility lost. As replenishment is only through leached nutrients and from adjacent catchments over agricultural forest lands, is further intense cultivation of fish is to be planned, only limited requirements for regeneration have to be met.

iv The roles of phosphates, nitrates, calcium, magnesium, potassium iron etc., in fertility of tanks are well known. However, the quantities of various inorganic and organic manures, lime or limestone required, are to be assessed and experimentally determined for each selected tanks and the most economical venues of supply have to be found. The known principles of enrichment of plankton or bottom organisms have to be followed up, and any nutrients accumulated or supplied, should not be allowed to be lost by overflows or absorbed by aquatic weeds which are apt to

explode into new growths in these tanks if sufficient care is not taken. Production of plankton and later filamentous algae to cover the surface, shading the tank thus inhibiting and finally serving to destroy the submerged vegetation, should be aimed at while fertilising tanks. Low water volumes in majority of tanks during summer are observed to increase availability of fertilising elements in bottom soils of exposed mud flats. These are further used as grazing grounds for cattle. Any growths of terrestrail plants submerged later, add further to the nutrients. Hence problems of correction and regeneration of irrigational tanks by artificial manures will not pose great financial commitments.

Weeds :

i Weedy tanks in Karnataka are responsible mainly for an overgrowth of murrels, and 'trash' or 'weed' fishes in the absence of more economical forms of fish which may feed directly on weeds or decayed organic matter produced. Besides utilising available nutrients in the water for their own growth, these weeds inhibit growth of plankton available to certain varieties of fishes. They also shelter several unwanted fish and obstruct effective fishing. The worst conditions created by excessive weeds is their successions from the submerged, floating or emergent stages to reedy swamps, accelerating silting and finally abandonment into grass land stage. In Karnataka, large swamps are rare but parts of many tanks are minor swamps. Such tanks are deliberately breached and are beyond reclamation.

ii Presence of excessive weeds are not known to have caused fish mortality by releasing unwanted gases or depleting dissolved oxygen by their large scale decay. On the other hand, they have kept waters clear from turbidity, serve both as food directly (indirectly while decaying) and harbouring aquatic food insects that have provided a subsistance fishery yield to village fishermen.

iii An aspect of economical use of at least one plant - Eichhornia (Water-Hyacinth) within Karnataka is its

extensive use as green manure and cattle fodder from tanks around Bangalore and also in Mysore , Gulbarga and some other districts where it may be found. Though Trapa is found in many Malnad, coastal and transitional zone tanks, cultivation of its fruit ("P.ani-phal") as in M.P. or elsewhere, is unknown in Karnataka. Further, the stems of Nymphea or Nelumbo for use as vegetable both raw or dried, is also unknown.

iv Many tanks (with the exception of canal - fed tanks) that are choked with certain dominant forms appear to indicate specific soil and water conditions. Chara is specific to calcium rich soils, Potamogeton to highly mineralised tanks (Southern Mysore Districts) and Vallisneria to iron rich soils. Some plants like Ceratophyllum appear to make use of otherwise sterile soils.

v The micro or algal vegetation is restricted mostly to the blue-green algae, as tanks wholly colonised by filamentous Spirogyra or Zygnema are rare; but in weedy margins, masses of these forms substantially add to the littoral vegetation, and accumulation of their decaying matter further hastens the silting processes brought on by higher aquatic plants. Microcystis characterises eutrophic conditions (majority of temple, village and sewage admixtured tanks) where 92 ppm or above organic matter is present. As far as is known it does not appear to have caused any menace to fish cultural operations. Submerged aquatic plants are killed by Microcystis blooms, which reduce light penetration as well as dissolved oxygen contents, thus checking their metabolic activities. Presence of Lemna spp., and Wolffia in manure enriched village ponds is a common feature. Utility of most of these ponds for holding breeder stock or as nurseries is envisaged already.

Fish 'Seed' Resources :

Any intensive stagnant water fish culture is dependent upon the young available to replace older ones removed from a tank. This process of 'autostocking' in Karnataka tanks is

restricted mainly to certain uneconomical forms which both phylogenetically and ontogenetically are incapable of growing to larger sizes. The species that are available are confined to murrels, spiny eels and some 'trash' fishes, as no major carps indigenous to Karnataka rivers or any Indian rivers, are yet to be confirmed to have bred within the tanks. 'Spawn'- or larval young of economical forms in the rivers are hence to be collected or desired varieties raised in fish farms for planting.

a. Natural Collections and Plantings :

i. Spawn : Efforts to procure spawn, fry and fingerlings of indigenous fishes, have not been successful in Karnataka as in some other States. Firstly, the species thus obtained are restricted to Labeo fimbriatus and L. porcellus in the rivers of the Krishna watershed. It is established that during monsoon floods, economical quantities of fertilised eggs and larvae of L. fimbriatus can be obtained at several points along the Tungabhadra and Bhima rivers. Rains and floods however, have to occur in time for successful collections. Fingerlings of L. fimbriatus are also obtainable but not in high concentrations along some of the major rivers. No other major species of the Krishna i.e. P. pulchellus, Tor spp. or even of Labeo calbasu are so far located to occur in abundance.

Procurement of spawn of major indigenous carps of the Cauvery river system (within Karnataka), like the Carnatic carp- Puntius carnaticus in monsoon floods has not been successful but where fingerlings are collected and stocked, results are rewarding as already noted in some tanks in Mysore and Hassan districts where Tor spp. similarly obtained from the river, are introduced.

Young of Puntius dubius of the Cauvery (breeding season being October-November months) has not been explored. The river does not hold any other major species except L. calbasu and L. kontius, which however occur seldom even in general catches above Shivasamudram water falls.

ii. Natural Planting : Of the indigenous major carps, only L. fimbriatus is known to have acclimatised to reservoir like tanks (Shantisagar, Madag, Vishnusamudra etc.) were a

sustained yield from year to year is available. In Bhutnal tank of Bijapur district, fry or fingerlings appear to enter through the surplus channels draining into the Bhima and a 'self stocking' of the tank is thus effected.

Some medium sized carps - Labeo boggut, L. ariza, Cirrhina fulungee and C. reba are naturalised variously in some perennial tanks (Shimoga and Arsikere tanks, Thimmappanayakankere, Vishnusamudra, Tallur tank etc.). These breed even on moderate flooding, and hence are self-perpetuating in several tanks.

iii. Major carps : Of the stocked non-indegenous forms, Labeo rohita fingerlings are reported in the Shanthisagar tank, their presence attributed to local breeding as no fry or fingerlings were introduced at the time. Eggs of Catla catla forming 2-5% were obtained with L. fimbriatus and Cirrhina reba in the seasonally active Vedavathi above Vanivilassagar. (This reservoir holds a naturalised Catla population forming an exclusive fishery and is the only watersheet above which its eggs or fry may be collected in Karnataka).

iv. Similarly availability of Milk-fish - Chanos chanos young as fry in Coondapur and other backwaters along the coastal belt, though recorded, has not been utilised for large scale rearing experiments, except a few tanks in the coastal zone itself.

Gourami, Tilapia and Etroplus breed in tanks and the natural sources of supply of these forms however are some tanks in South Canara district. Some Malnad tanks also hold Etroplus young, but not in sufficient numbers to be exploited on a large scale.

v. Murrels, especially Channa marulius, C. leucopunctatus and C. striatus that form major part of fish yield from tanks even now, can be stocked as fingerlings in the extensive canal connected weedy tanks where major carp culture cannot be practised. Fingerlings of murrels are available in several tanks in required quantity during May-June and October-November months if murrel culture is taken up within the State on a scientific basis.

Fish Breeding :

There are 17 fish farms in Karnataka State, where 25-30 acres (10-12 ha) of fish nursery and breeder holding spaces are now available. While in none of the farms indigenous species of major carps are kept, Gangetic major carps (Catla catla, Labeo rohita and Cirrhina mrigala) are variously tried for pituitary induced breeding experiments. A total of 1,000 major Gangetic and common carp breeders are held within the ponds (500 of each category) of Tungabhadra farm. This farm has produced in 1964, 1965 and 1966, some 62, 76 and 230 lakh hatchlings and raised 11 to 28 lakh fry of major Gangetic carp respectively. Similarly 5.2 and 2.5 lakh hatchlings and fingerlings of common carp were raised during 1965-66.

Most fry are stocked directly into selected perennial tanks as the nursery space available in farms is scanty in each of the districts. Some are reported to be stocked into natural 'nursery' tanks within certain municipal limits (e.g Haveri) and fingerlings later recovered for stocking elsewhere. As selection and preparation of these natural nurseries require considerable care and attention well in advance, results do not appear to be very encouraging.

The Bangkok strain of common carp - Cyprinus carpio has yielded better results in fish farms, with the Hessarghatta farm raising considerable numbers. Tungabhadra Board farm also raises enough C. carpio to meet the demand from Blocks and Departmental tanks in central and northern Karnataka.

A well organised fish farm holding sufficient fish breeders and providing well prepared nursery ponds alone can produce required amount of 'seed'. It is also likely that ripe individual major fishes in the process of ascending for breeding may successfully be induced to breed artificially. Minimum stock of breeders must be built up for various types of breeding work.

Total requirement of fish seed of major carps, the number of sets to produce them and space required to hold them and raise fry and fingerlings are indicated in table 9. Calculated on the basis of perennial water sheets available in each district to be stocked at a modest rate of 500 fingerlings per acre, the

TABLE - 9

Districtwise Fish Seed requirement of Perennial tanks (A) and tanks above 1000 acres (B) in water spread

District	Perennial Tank Waters in acres	Fingerlings required	Fry to be raised	Hatchlings to be produced	No. of breeders required (in acres)	Nursery space required (in acres)	Breeder holding space (in acres)	Minimum water spread require in Fish farm
1	2	3	4	5	6	7	8	9
A								
Bijapur	4710	2355000	7065000	14130000	64	0.97	1.60	2.50
Gulbarga	2787	1393500	4180500	8361000	38	0.57	1.00	1.50
Raichur	885	442500	1327500	2655000	12	0.12	0.30	0.50
Dharwar	7259	3629500	1088500	21777000	99	1.50	2.50	4.00
Belgaum	3170	1585000	4755000	9510000	43	0.15	1.80	1.25
Mysore	17127	8563500	25690500	51321000	233	3.50	5.80	10.00
Chitradurga	13265	6632500	19897500	39795000	181	2.70	4.50	7.00
Tumkur	18235	9117500	27352500	54705000	249	3.80	6.10	10.00
Shimoga	30000	15000000	45000000	90000000	409	6.20	10.20	15.00
N. Canara	2016	1008000	3024000	6048000	27	0.42	0.68	1.00
Bellary	4030	2015000	6045000	12090000	55	0.84	1.40	2.25
S. Canara	139	69500	208500	417000	2	0.03	0.05	0.50

contd.....

1	2	3	4	5	6	7	8	9
Kolar	5343	2671500	8014500	16029000	73	1.40	1.80	3.25
Bangalore	8255	4127500	12382500	24765000	112	1.70	2.80	4.50
Chickmagalur	1950	975000	2925000	5850000	26	0.40	0.70	1.00
Hassan	10642	5321000	15963000	31926000	145	2.20	3.60	6.00
Bidar	1356	678000	2034000	4068000	18	0.28	0.45	1.00
Mandya	12105	6052500	18057000	36115000	164	2.50	4.10	6.50
Coorg	1136	568000	1704000	3408000	15	0.23	0.38	1.00
	144410	72205000	216514500	432970000	1965	29.51	49.76	78.75
B								
32 tanks above 1000 acres	57000	28500000	85500000	171000000	777	11.70	19.40	31.00

Stocking rate per 100 acres of water = 50000 fingerlings at 500 per acre
= 150000 fry
= 300000 hatchlings
= 2 sets of 2.5 Kg females producing 2.0-2.75 lakh eggs each

Survival from eggs to hatchlings = 75%
Hatchlings to fry = 50%
Fry to fingerlings = 35%

Breeder holding space calculated at 100 Kg weight of fish per acre which may be reduced by 50-60% under ideal conditions.

Total Fingerlings required in the State - 100705000 - 10 crore
No. of Breeders required - 2742 sets or 2800 female fishes approximately.
Total average under Fish Farm : Nurseries - 41.21 acres
Breeder holding space 109.75 acres
Total : 150.96 acres
= 151 acres approximately.

targets may easily be attained. The tanks of over 1,000 acres (400 ha) mentioned separately, require additional breeders and space to serve them as these tanks require individual handling programmes of a type designed to yield a regular, commercial catch.

Acclimatisation :

Catla fingerlings orginally introduced in 1934 within Vanivilassagar has resulted in its continued fishery as the species breeds above. Between 1940 and 1946, experimental stocking by Catla fingerlings from the Godavary delta, Gourami - Osphronemus gorami and the 'Pearl spot' Etroplus suratensis were procured and their young sought to be raised in two fish farms. Both Gourami and Etroplus reproduced in the farms, and young were stocked within the Markonahally and Markandeya reservoirs. While Gourami has disappeared, Etroplus has formed a profitable fishery in the Markandeya reservoir. It is also being propagated within the Coast and Malnad tanks; Gourami is now held only in the coastal tanks, but its response appears to be not good. Catla, Rohu and Mrigal introduced in later years and sotcked intensively since 1952 as fry directly or as fingerlings have not known to have spawned anywhere naturally. While they are grown quite successfully in some tanks, spectacularly increasing fish yield, in majority of tanks results have been poor. Except for a reported breeding of Labeo rohita in Shanthisagar reservoir and for collection of well grown fingerlings of Catla and Rohu in a tank (Navlur) in Dharwar district where adults kept earlier evidently bred once under seminatural 'Bundh' conditions created by rains and flooding, none of the stocked major carps are now known to have naturalised in tanks as in Andhra Pradesh.

Non-survival of fry directly introduced into most tanks, removal of almost all adults and breeders from likely tanks and connecting streams above during floods, and failure of proper floods and rains in time even if breeders are available, are causes for their nonmultiplication and failure at self-perpetuation in large perennial tanks unlike in Andhra Pradesh where several tanks now act as 'bundh' tanks providing their own supply of fish seed.

The common carp Cyprinus carpio (Linn.) and its variaties i.e. scale carp- C. carpio communis, Mirror carp- C. carpio specularis were stocked in Mysore since 1949-50 after being held in some of the fish farms. Since 1958-59 after the Bangkok strain of C. carpio was brought into Karnataka and induced to breed in various farm ponds, it has become naturalised. Its contribution to the main fishery with Mirror carp in Hessaraghatta and Bellandur tanks, shows that the fish has multiplied. Though in deeper reservoirs it has not greatly survived, stray eggs, larvae, fry and fingerlings are reported from several tanks. Survival of young is poor as both breeder stocks and young are destroyed either by over-fishing or become victims to the predators. Owing to protection offered continuously in the past years, the species has naturalised in Hessaraghatta tank along with Mirror carp. Premature removal of its fingerlings in huge numbers from Bellandur tank in 1963-64, has resulted in the dwindled fishery in the tank.

The freshwater Mullet- Mugil corsula (Liza corsula) is naturalised within the Markandeya reservoir, introduced accidentally with Gangetic carp fry brought from Calcutta initially. As its distribution is unknown in the South (though imported to Tamil Nadu earlier) this fortuitous introduction in Karnataka waters is of some interest. Similarly the predaceous freshwater Goby- Glossogobius guiris has been stocked within tanks of the Cauvery catchment, entering the river courses where its presence is attributable solely to inadvertent stocking.

The Grass carp- Ctenopharyngodon idellus (V), the silver carp- Hypopthalimichthys molitrix (V) and the Big Head- Aristichthys nobilis (Richardson) are being reared experimentally in Hessarghatta fish farm, and attempts are affot to raise their spawn and fry. As these species have responded in Cuttack both in growth and to induced breeding beyond expectations (maturing and attaining 1/2 to 2.6 Kgs within a year), interest in their introduction and acclimatisation will perhaps be of greatest benefit to fish production in Karnataka tanks.

Average and approximate growth rates of all the above species in freshwaters, especially in tanks of S. India, are presented in table 10. While stocking any tank, after removal of most trash or wildfish, three or more good species of fishes should be introduced to ensure better yield. Selections must be decided on the basis of known habits of fish and nature of tank.

TABLE - 10

Growth and other features of some fishes useful in Tanks in Karnataka

Species	Growth			Year	Remarks
	cm	Inches	Wt. Kg		
(1)	(2)	(3)	(4)	(5)	(6)
Major Carps :					
Catla catla (Ham.)	45-60	17-23	0.2-3.2	I-II Year	Such fast growths are common in fertilised tanks, normal growth being slightly less in most tanks. The fish can be removed in 2nd-3rd years after stocking when about 3-5 Kg in weight.
Labeo rohita (Ham.)	23-38	9-12	0.5-1.0	I Year	Growth of about 35 cm (14") are recorded in Tamil Nadu tanks, but does not grow so well in normal irrigational tanks. 2-3 Kg weight of fish in the 2-3rd years after stocking are economical to be removed.
	35-40	13-15	1.0-2.0	II Year	
Cirrhina mrigala (Ham.)	38-60	15-22	1.1-1.8	I Year	Such growths are exceptional to good tanks; 2-3 Kg weight of fish after 2 years of stocking are economical for cropping.
Cyprinus carpio (Linn.)	23-30	9-12	0.5-0.75	I Year	The species and its varieties, are fast growers, attaining 49-50 cm (19") in one year in good ponds. Attains maturity in 8-10 months, spawning in many of the Karnataka tanks where introduced, attaching eggs to floating or submerged-vegetation.
C. carpio specularis (Linn.)	50	20	1.5-3.0	II Year	
Cirrhina cirrhosa (Bl.)	40	15-16	1.5	I Year	Growth of up to 40 cm (16") and 60 cm (24") in Ist and IInd Years are recorded in some tanks of Tamil Nadu. Not found or tried in Karnataka waters. But the growth recorded appear to be abnormally high for a river fish, but about 1/3 - 1/2 recorded growths can be expected if stocked in Karnataka waters.
	61	20-24	2.5	II Year	
Labeo fimbriatus (Bl.)	23-30	9-12	0.2-0.4	I Year	These sizes are attained in most tanks by the two species, growth being faster in tanks than in rivers depending upon food available; Occasionally young (spawn and fry) occur in sufficient numbers in rivers for stocking.
Labeo calbasu (Ham.)	25-30	10-12	0.3-0.4	I Year	
	30-40	12-16	1.0-2.0	II Year	

contd.....

(1)	(2)	(3)	(4)	(5)	(6)
Labeo kontius (Jerdon)	25-30	10-12	0.5	I Year	Attains the recorded sizes and weights in some ponds (Tamil Nadu), but attaining maturity at about 30 cm, may be considered as a medium sized carp. Fry are scarce.
Puntius dobsonii (Day) = P. pulchellus (Day)	13	5	0.07	I Year	These sizes are recorded in Tungabhadra and Anjanapur Reservoirs; spawn and fry are scarce. P. pulchellus is known now to feed extensively on vegetation and may easily control water weeds in a tank similar to the exotic Grass carp.
	31	12	0.4	II Year	
	47	18	1.8	III Year	
Puntius carnaticus (Jerdon)	23-25	9-10	0.15-0.2	I Year	Appears to respond well in tanks. Spawn and fry are scarce.
Puntius dubius (Day)	-	-	-	-	Not much is known of its growth.
Medium Sized Carps :					
Puntius sarana (Ham.)	14-16	5-6	0.2-0.3	I Year	Though slow growing in rivers, can grow exceptionally fast (23-25 cm) in fortmoats and organically rich tanks. Attains maturity when of 12-14 cm, breeding in most of the tanks during rains in Karnataka.
	21-24	8-10	0.3-0.4	II Year	
Puntius kolus (Sykes)	10-15	4-6	0.1-0.2	I Year	A river form, occasionally available in some tanks. Not of any great importance in tanks.
Labeo bata (Ham.)	18-23	7-9	0.2-0.5	I Year	Though poor in growth, makes up by numbers; introduced in many tanks with major Gangetic carp fry.
Labeo boga (Ham.)	30-38	12-15	0.4-0.6	I Year	These growths are recorded in Tamil Nadu, but are exceptional to tanks. Both forms enter some tanks where they appear to have bred in Karnataka.
Labeo ariza (Ham.)	40-46	16-18	1.0-1.2	I Year	
Labeo boggut (Sykes)	12-15	5-6	0.06-0.8	I Year	Frequent in most tanks in Karnataka; breeds in larger tanks.
Cirrhina reba (Ham.)	22-28	9-11	0.09-0.2	I Year	-do-
Cirrhina fulungee (Sykes)	15-20	6-8	0.04-0.06	I Year	-do-
Labeo porcellus (Sykes)	-	-	-	-	Not much is known of this fish entering tanks from rivers.

contd.....

(1)	(2)	(3)	(4)	(5)	(6)
Backwater & other forms :					
Chanos chanos (Forskol)	40-60	16-25	3.0-4.0	I-II Years	Fry obtainable in Coastal backwaters; when introduced in fresh-water tanks grows very fast. Not exploited properly in Karnataka
Mugil cephalus (Forskol)	30-60	12-24	1.5-3.0	I-II Years	-do-
Etroplus suratensis (Bl.)	20-26	8-10	0.3-0.5	I-II Years	Stocked in several tanks; Spawns in confined waters. Young are not fully exploited from breeder tanks in Karnataka.
Osphronemus gorami (Lace.)	15-20	6-8	0.5-0.7	I Year	Confined only to Coastal ponds now; fry are not exploited as yet properly for extensive stocking.
Tilapia mossambica	21-33	8-10	0.15-0.2	I Year	Prolific breeder in tanks, in 8-9 months, 2-3 generations being produced; at present recommended to be grown only in Coastal ponds owing to its wild growth, which may effect other species.
Predaceous species :					
Channa leucopunctatus (Sykes)	40-60	16-25	1.5-2.2	I-II Years	
Channa marulius (Ham.)	40-60	16-24	1.5-2.0	I-II Years	Highly predaceous; breed in tanks.
Channa striatus (Bl.)	30-36	12-14	0.5-1.0	I-II Years	
Channa punctatus (Bl.)	20-26	8-10	0.2-0.3	I-II Years	
Ompok spp. (2)	25-33	10-13	0.15-0.2	I Year	Breeds in most of the tanks.

contd.....

(1)	(2)	(3)	(4)	(5)	(6)
Wallagu attu (Bl. & Schn.)	30-34	13-25	0.5-1.0	I Year	In canal connected and large reservoir like tanks the species is generally found; does not spawn in most of the tanks.
	35-60	20-26	2.0-4.0	II Year	
Mastacembelus armatus (Lace.)	10-16	4-7		I Year	
	20-26	8-11		II Year	These 'spiny' eels occur naturally in almost all tanks spawning within the tanks.
	37-43	14-17		III Year	
Mastocembelus pancalus (Ham.)	15-20	6-8		I Year	
Notopterus notopterus (Pallae)		8-12	0.2-0.3	I Year	Very predaceous 'weed' fish natural to large tanks; not economical.
		13-15	0.3-0.5	II Year	
Lates calcarifer (Bl.)	30-46	12-18	0.4-0.8	I Year	Obtainable in backwaters as fry; not tried in Karnataka.
	50-60	20-24	1.0-2.0	II Year	
Others					
Ctenopharyngodon idellus (V)	43-49	17-20	0.9-1.4	I Year	These are the Chinese 'Grass' carp and 'Silver' carp respectively, which are responding very well in India in growth and also amenable to induced spawning. Grass carp keeps a check on weeds in a tank.
Hypopthalimichthys molitrix (V)	38-57	15-22	0.5-2.0	I-II Year	

Exploitation of fish populations:

Tanks in Karnataka are exploited indifferently as no account is taken of the condition and nature of fish population, nor factors limiting their sizes or abundance are considered. While harvesting fish from tanks that possess low waters, no attempts are made to ensure some useful stock for regeneration in the next season, even if it is only some 'trash' fish. Fishing though dependent upon the location, demand and skill of surrounding communities, nature of tank and species of fish, once licenses are issued and leases are released, exploitation is purely at the discretion of the fishing agency. Depths of over 2½-3 m, vegetation that obstructs fishing or expansive tanks, however remain only partially exploited (tanks in Shimoga, Bellary, Tumkur, Mandya, Mysore and Hassan districts). Balanced fishing in tanks within Karnataka will ensure assured supply of fish to consumers.

On the other extreme in tanks of Northern Karnataka (Bijapur, Bidar and Gulbarga), though stocking has been done over a number of years and a good standing crop of fish has resulted, the local fishermen mostly do not have the little skill to operate gill or drag nets. Tanks at Tadavalaga, Arishankar and Kalskoppa in Bijapur, Vazirbagh, Tipranth and Narayanpur in Bidar and all the tanks except the sewage fed Sravanabasaveswara tank in Gulbarga districts are examples. Many such tanks all over the state are subjected to pressures of one kind or the other and tanks rich in fish stocks or those that are about to dry up naturally attain importance.

In Hassan district, tanks produce about 17 Kg per acre, 85 Kg in Dharwar and 15 Kg in Tumkur tanks (table 11). These figures are very unreliable as there is no agency recording fish removed, and there is always a tendency to play down the catches. An estimated capture of about 50 Kg per day for 80-90 days of fishing in Machche tank in Belgaum dt., totalling to about 3,500 Kg for 7½ acres, works at about 500 Kg per acre. This is the standing crop as all fish were removed owing to breaches and the tank was consistently stocked with major carps in previous years. Clarias batrachus alone estimated at 1,000 Kg (or nearly 4 cartloads) is reliably learnt to have been taken from a 4 acre pond in Tirthahalli taluk during monsoon

TABLE - 11

Known Fish Yield from Tanks & Reservoirs in Karnataka

Sl. No.	Tank/Reservoir	Water spread area in		Yield in (Kg)	Year	Yield in Kg per		Remarks
		Acres	ha			Acre	ha	
1.	Tungabhadra Reservoir	93440	37814	119000	1964-65	1.3	3.1	
2.	Vanivilassagar	17280	6981	55239	1963-64	3.2	7.9	
				53125	1964-65	3.7	7.6	
3.	Markonahally	3303	1334	40000	-	12.0	29.0	
4.	Markandaya	840	339	1500		1.8	4.4	
5.	Hessaraghatta tank	1399	565	12000		21.6	53.5	Average catch per year
				1699	1960-61	1.2	3.0	Departmental catch, April to Oct. only
				2124	1961-62	11.5	3.7	
				5972	1962-63	4.2	10.5	
				6258	1963-64	4.5	11.0	
				4382	1964-65	3.1	7.7	
6.	Bellandur tank	834	337	26054	1962-63	31.2	77.1	
				37557	1963-64	45.0	111.4	
				21407	1964-65	25.6	63.5	April to Oct.
7.	Ramasagara	1200	485	1800		1.5	3.8	
8.	Koppa tank(Mandya)	534	216	4000		7.5	18.5	
9.	Thimmegowdankere	40	16	600		15.0	37.5	
10.	Arsikere tank	444	179	1250		2.9	7.0	Average catch per year, mainly *W. attu* *L. fimbritus*
11.	Thimmappanayakanakere	555	224	758	1962-63	1.3	3.4	Only Deptl. catch, figures available *L. fimbriatus* dominated *Catla catla*, *W. attu*.
				318	1963-64	0.5	1.4	
12.	Bethamangala	1020	412	50000		48.0	121.0	
13.	Machche (Belgaum Dist.)	7½	3.03	3500		46.6	116.6	Refers to "standing crop" removed on breaching
14.	Hoskere-Shimoga Dist.	4	1.6	1000		250.0	625	Refers to *Clarias* spp only.

flooding; under such circumstances, it is possible that several indigenous and planted species do possess high standing crops and if properly exploited and managed, their yield could equal to tanks elsewhere in India.

While majority of tanks are fished all the year round and no account of landings are available except on occasions at the time of low water intensive fishing, many tanks are fished only peripherally by cast nets and drag nets for a subsistance fishery by fishermen. Malnad tanks are comparatively fished less owing to weed infestation, greater depths and sunken forest litter deter frequent use of nets. But during floods above or surplus discharges once a year or so, in almost every tank, the channels are barred by villagers and any migrating fish from or into the tanks, are removed. This naturally results in the decimation of a tank ultimately as any invading forms from the river or streams close by or from connecting tanks above or below, are totally fished. Removal of fish from year to year during floods coupled with low waters during summer have made tanks to hold mainly 'trash' fish.

Problems of maintaining balanced fish populations in Karnataka tanks in keeping with their productive capacity if solved to some extent, will probably render many tanks to easily hold higher self-generating stocks of fish. Some equilibrium between the 'trash' fish and murrels - catfishes (Clarias, Heteropneustes, etc.) appears to have been established in Malnad and the weed-infested tanks elsewhere, while the tanks in Central and Southern Karnataka seem to be over exploited leaving unbalanced fish populations. It is apparent from the species of fishes, that almost all the fish-food produced in tanks, is consumed by numerous 'trash' forms which after an initial fast growth, remain small (e.g. Puntius spp of minnow carps, Rasbora, Esomus, Amblypharyngodon, etc.). These are fed inturn by other unwanted forms (Notopterus), and some desirable varieties like the murrels, Clarias, Ompok, spiny eels, Mystus vittatus, M. cavasius, etc. Though it is not advisable to allow local fish to breed indiscriminately, it is not possible to control them either at present.

Present fish production is now computed at 60 Kg/acre (148.26 Kg/ha) in perennial and 10 Kg/acre (24.71 Kg/ha) in seasonal tanks and 10 Kg/acre (24.71 Kg/ha) in reservoirs in Karnataka on the basis of production figures noted. Total quantity now produced from the above resources amounts to a calculated 29,678 tonnes or 30,000 tonnes nearly per year. This compares well with the marine landings of the State. This production can easily be doubled or even tripled, with some manipulations in fishery management and control and also by intense stocking and rationalised exploitation.

It has been demonstrated with success that it is possible to raise as much as 2,080 Kg/ha of fish in small village ponds which would be otherwise lying fallow. Sustained continued supply of fish could be achieved even in small irrigational tanks as has been demonstrated by the Tank Fisheries Research Unit in tanks in a Block under Applied Nutrition Programme. Fish at the rate of 790 Kg/ha could be raised in a perennial 3 acre (1.25 ha) tank. Even irrigational tanks of seasonal nature have been shown to produce 179 Kg/ha of fish during their water retention period extending between 6 and 8 months.

RECOMMENDATIONS

Based on the observations, during the random surveys in Karnataka State, reported of here, the recommendations those may be useful for further works are as follows :-

A. Water Resources :

i. Surveys to be conducted by departmental staff in all districts and taluks listing every perennial, seasonal, town, municipal, village, temple and other tanks.

ii. These surveys should be mainly with a view to hold breeder stocks (temple, town, and village ponds), possible 'bundh' type and natural nursery tanks for breeding and raising young of desirable species and to ascertain possibilities of raising short time fish crops in seasonal tanks.

iii. P.W.D., Irrigational and Agricultural authorities should co-ordinate and help the fish raising and exploitational programmes, by agreeing to regulate the waters of tanks as far as practicable.

B. Selection of Tanks :

i. Districtwise selection of tanks for development to supply fish to larger towns, cities and markets to be undertaken, on a self-contained basis with regard to needs of breeders, space and raising or collecting fish seed.

ii. Zonewise selection of tanks as per their inherent capacity for fish cultivation may be undertaken.

a. Murrels, catfish, perches, Mahseers (Tor spp.), Chanos etc. - to be mainly raised in the Coastal and Malnad tanks, with possible additions of grass carp and frogs.

b. All major carps, common carp, Pangasius and any similar fish and prawns to be cultivated in the transitional, black and red soil tanks.

c. Breeding 'bundhs', natural nurseries and fish farms can be mostly situated in the transitional zone where rainfall and soil conditions are favourable.

d. Rearing ponds for fry and direct stocking of fry can be undertaken on a large scale in black soil tanks with great advantage.

e. Red Soil zone requires maximum scope for seed raising and experimental fish farming as tanks are numerous in Central and Southern Karnataka where an intensive fish cultivation programme may be undertaken. This area offers numerous opportunities to try various pond cultural operations inclusive of eradication of 'trash' fish, weed control, liming and manuring practices and also combinations of fish species as well as murrel culture.

iii. The breeder holding ponds, 'bundh' or natural nursery tanks should be ancillary to the fish farms to supplement farm requirements as also of tanks nearby.

C. Preparation and Correction of Tanks :

i. Determining by primary production experiments - deficient minerals, salts and other nutrients in selected tanks.

ii. Liming and adding phosphates to make tanks yield better fish food organisms are already indicated variously in Malnad tanks (liming), red soil tanks (liming and manuring). As larger tanks cannot be corrected easily, selected small tanks, where results can be properly checked, may be undertaken for studies. Various combinations of inorganic and organic manures and other salts may be experimented.

iii. Some tanks, being either isolated or for other reasons, may not have correct types of food organisms. 'Seeding' such tanks with proper biotal organisms especially oligochaetes, insects, molluscs and even certain types of plants, may encourage their colonisation supplementing the food of fishes.

iv. Removal of unwanted 'trash' fish before stocking with desirable species should be done.

a. During droughts when all fish die (as in 1965-66)

b. Poisoning selectively to remove murrels, catfishes etc., or whole populations. No poisons harmful to man and domestic cattle to be used or if used, only those known to possess toxicity for short periods should be used.

c. By using other methods,e.g. intense, unrestricted fishing lowering water levels etc.

v. Retaining useful fishes for multiplication and preventing invasion of undesirable forms. Provision of small sumps dug in the drying bed will help retention of useful forms, and similarly incursion of murrels, catfishes etc. from other sources have to be prevented. These require attention individually in each tank, as each tank should possess self-generating stocked of fishes as far as possible.

vi. Desilting of tank beds and digging trenches on the periphery where some swampy vegetation may be growing to further prevent its incursion. Present day haphazard desilting practised by villagers can easily be made to fit into fish cultivation programmes. There are a few tanks in Karnataka requiring ploughing and exposure to sunlight of mucky bottom soils.

vii. Control of blue-green algae blooms- Microcystis, Anabaena, Oscillatoria etc.- mainly in village and temple ponds for use as breeder holding or nursery ponds.

D. Weed Control:

i. Control of submerged and emergent plants, as well as sedges and reeds specifically which choke tanks, by various weedicides as manual labour may not serve to eradicate them completely. But comparatively cheaper methods using manual labour or weed killers or even fertilisers and combinations of these methods have to be devised by actual field operations.

ii. Usefulness of combining fertilising agents to prevent submerged gegetation by facilitating growth of algal scum to obstruct light penetration, and by creating other unfavourable conditions that choke weeds, may be studied.

iii. Control of weeds by changing the structure of the soil by administering to the soil various salts or chemicals.

iv. Determining the optimum requirement of useful vegetation to provide enough direct food or indirectly by decay and detritus formation and harbouring invertebrate food organisms.

v. Usage of various plants as cattle food, farm manure (compost) and exploring usefulness of Trapa and Nelumbium etc.

vi. Biological control of weeds, by introduction of fish which feed mainly on plants (grass carp, Puntius pulchellus, gourami, common carp etc.) or keep the water turbid preventing light penetration by disturbing the bottom mud, may be given trials.

E. Fish 'Seed' Resources :

i. Natural collection to be intensified.

a. Collections of spawn, fry or fingerlings of Labeo fimbriatus, L. porcellus, Tor spp. and other indigenous forms from the rivers of the Krishna system.

b. Collection of spawn or fry or fingerlings of Puntius carnaticus, P. hexagonolepis, P. dubius, Tor sp. from the Cauvery system.

c. Collection of both adult and young of medium sized Puntius sarana, Labeo ariza, L. boggut, Cirrhina reba, C. fulungee and minor Puntius dorsalis (P. puckelli), P. stigma, P. amphibius, Amblypharyngodon spp., Esomus, Rasbora, Oxygaster spp. etc. from rivers, streams and also tanks for stocking seasonal tanks.

d. Exploration and intensifed collections of fry of Chanos chanos, Lates calcarifer, Mugil cephalus and others from backwaters.

e. Exploration for young of murrels, Etroplus, gourami or Tilapia as the case may be from tanks.

f. Location of breeding grounds of major forms close to tanks and reservoirs and collection of eggs or spawn in the vicinity (e.g. Vedavathi at Kellodu, Chowrdi above Anjanapur etc.

ii. Induced breeding of selected varieties fully to be developed.

a. Pituitary injection experiments to be accelerated at each of the fish farms.

b. 'Bundh' breeding experiments to be extended after building up proper stock of breeders in nearby tanks.

c. Injection experiments upon naturally occuring 'wild' breeders during the time of their ascent into streams from large tanks and reservoirs (e.g. Catla, Labeo fimbriatus above Vinivilassagar, and Labeo rohita above Shantisagar).

d. Breeding of Common carp- Cyprinus carpio extensively in confined waters.

iii. Import of suitable fish young and spawn for stocking:

a. Grass carp- Ctenopharyngodon, Silver carp- Hypopthalmichthys, Big Head - Aristichthys, Black carp- Mylopharyngodon for raising 'seed'.

b. Pangasius pangasius, Cirrhina cirrhosa and other useful forms from various drainages for stocking and especially within Karnataka below Shivasamudram falls.

c. Fast growing freshwater prawns- Macrobrachium malcolmsonii, to be tried both for stocking as well as to raise the young locally.

F. Stocking and Planting Programmes :

i. Until such time as predaceous and other harmful fish are not controlled, only fingerlings of various species to be planted in perennial tanks in sufficient numbers.

ii. Fry of desirable forms to be introduced only in selected tanks where no danger for their survival exists- (e.g. murrel- free tanks).

iii. Stocking combinations, rates and so on to be decided for each tank individually, depending upon its capacity to hold them. At least three species should be stocked to derive the greatest benefit.

iv. Cultivation of murrels, Clarias etc. to be augumented where their fishery already exists and cannot easily be eradicated (e.g. Malnad tanks).

v. Seasonal tanks holding water for 6-10 months can be stocked with medium and minor sized carp young or adults as they are likely to spawn during filling and provide a considerable supply of fish at the time of drying. Mixed culture of carps and murrels can be tried in seasonal tanks.

vi. Paddy-cum-fish culture, even if it is to raise minor forms given extensive trials in rice fields, areas suitable are in the commanded area of Tungabhadra and Tungabhadra river dams.

G. Exploitation of fish populations:

i. Improvement of existing fishing methods in partially exploited tanks.

a. Use of coracles, rafts, floats or boats to be encouraged in all large tanks.

b. Gill nets, bottom nets, traps or trap nets, and other devices at fishing to be experimented upon and utilised.

c. Devising effective methods of fishing in weed infested tanks.

ii. Arranging effective fishing in unexploited tanks by coracles gill nets etc. (Northern districts of Karnataka).

iii. Follow up of information of migrating or invading fish from tanks to tank during rains (Clarias) and also the escape and ingress of various fishes involved in self-planting of tanks.

iv. Studies on fish removal in large reservoir like tanks to assess the productive capacity, regulate gears, mesh sizes of nets, numbers of fishing units, limiting sizes of fish and number and quantity, protecting breeders, and young and natural nurseries in relation to such tanks and preventing over fishing.

v. Records of fish production along with relevant data from month to month, to be kept in some selected tanks districtwise. Samplings also to be undertaken.

H. Population studies :

i. Biological studies on selected tank fishes to ascertain their growth, age, food, fecundity and breeding, and relate these factors with the ecological conditions.

ii. Studies on fish composition to develop balanced fish population in selected tanks.

iii. Studies of fish growths in specialised tanks or environments i.e. sewage fed tanks, fort moats, weed infested tanks, village, town municipal, temple and other tanks, to use such derelict tanks for fish production.

iv. Experimental assessment of fish production in tanks of various zones and related factors determining their biogenic capacities. These include studies on growths, food, fecundity and other biological aspects as (i) above.

SUMMARY

The irrigational tank resources in Karnataka total to 2,96,316 ha of which 2,13,971 ha are partially utilisable for short time fish cultivation programme, being seasonal. These seasonal tanks number 20,588. Perennial tanks numbering 2,187 possess a maximum water spread of 82,345 ha. Besides, 1,07,470 ha in deep reservoirs and atleast 2,130 Km lengths of canals, offer one of the richest areas for cultivated and controllable production of freshwater fish in India.

The tanks differ in basic productive capacities according to the geographical and climatological conditions as 'Coastal', 'Malnad', 'Maidan' regions, as well as soil types, viz-i. Lateritic- Coastal and Malnad, 2. Transitional- Red and Black soils, 3. Black soil and 4. Red soil zones. The physico-chemical, biotal and plankton characteristics differ basically from zone to zone as brought out from a random sampling of about 350 tanks spread over the 17 out of the 19 districts of the State.

Fish life in tanks is distinct from the riverine types, and mainly the murrels, some catfishes (Clarias, Heteropneustes, minor Mystus spp.), spiny eels (Mastacembelus, Rhyncobdella), minnow carps- (Puntius spp.) and other 'wild' or 'trash' fishes- (Esomus, Rasbora, Amblypharyngodon, Oxygaster) variously, and in some tanks- Notopterus, Ompok, smaller Labeo or Cirrhina constitute the bulk catches. The natural zoogeographical features of river drainages containing few major species of fishes have greatly influenced the tank fish fauna. Largest forms have greatly influenced the tank fish fauna. Forms indigenous to the rivers of Mysore plateau that occur occasionally in some tanks being slow growing species like Labeo fimbriatus and Puntius carnaticus have not added to the natural fish wealth of tanks to any appreciable degree. Wallago is the only major catfish that occurs in some large or canal connected tanks.

The tanks that are stocked with fingerlings of major Gangetic carps- Catla, Rohu and Mrigala or Common carp- Cyprinus carpio have yielded very good results as also some tanks where 'fry' of these are directly stocked. In most

districts, the public have recognised the merits of these forms and realised the value of quality stocking in tanks that otherwise held only a subsistence fishery of slow growing or small forms. But the rate of stocking and other measures designed to make the tanks yield better crops have been inadequate and are not followed up for assessment of results.

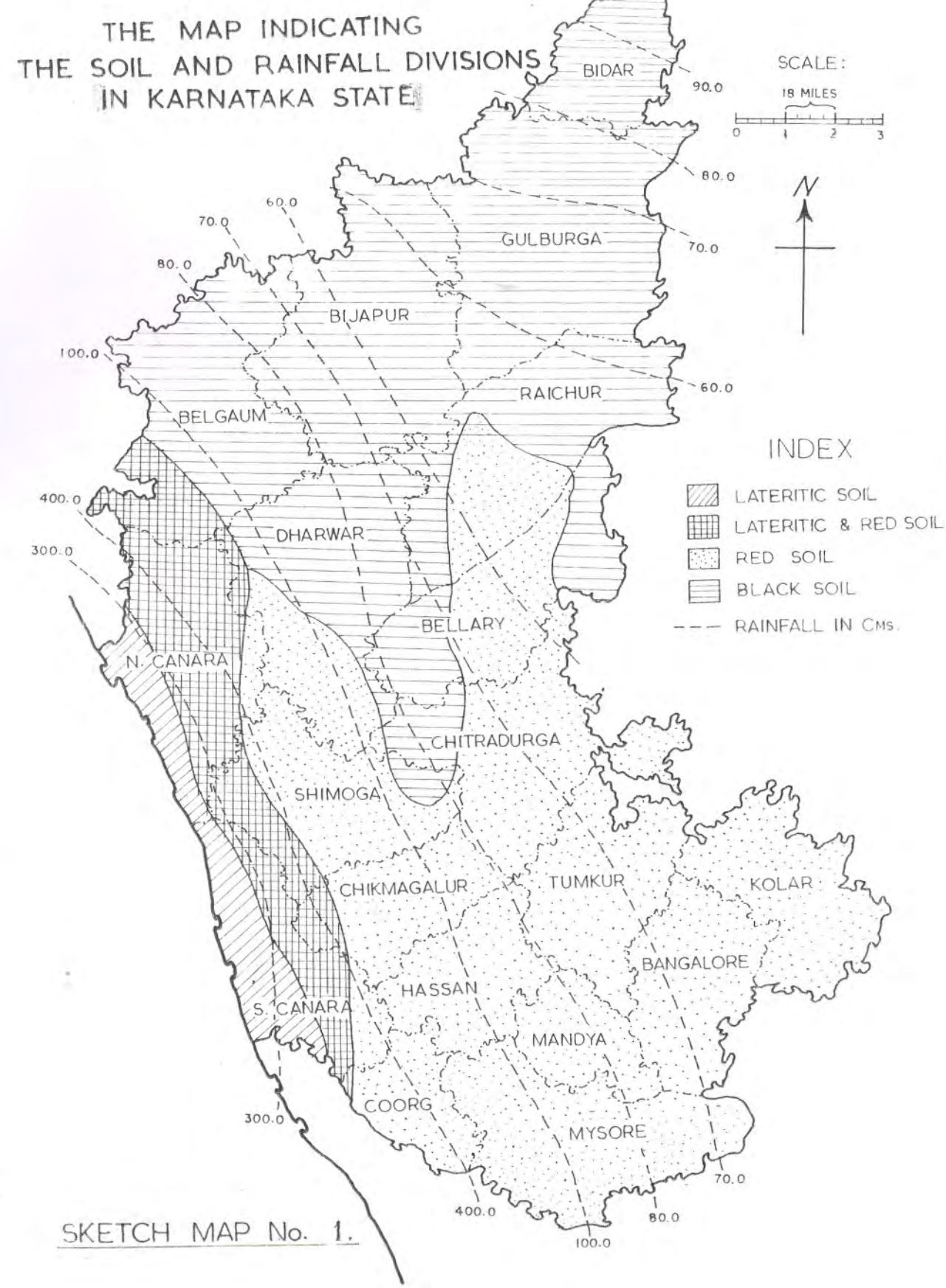
The unbalanced fishing practices in tanks stocked with the fast and large growing species, over-whelming presence of predaceous forms and 'trash' fishes (especially in weed infested tanks), appear to have contributed towards production of fish being still not commensurate with potentiality of tanks for fish production.

Fish seed resources of the state for local major carps is restricted to only one or two river forms. In none of the tanks the major Gangetic carps have spawned or otherwise naturalised due to inadequate breeder stocks and lack of protection. Common and Mirror carps have spawned in many tanks but none have produced so far natural fish 'seed' as they are to be still raised like major Gangetic carps in some of the fish farms under controlled conditions. Exploration of resources for other forms of proved worth for tank fish culture (Chanos, Mullets etc.) has still to be undertaken.

The developmental measures now suggested include fish farms, natural nurseries, breeder holding ponds and raising and stocking of parent fish and their young on a district-wise or sub-zonal basis to meet specific local requirements of tank resources and markets.

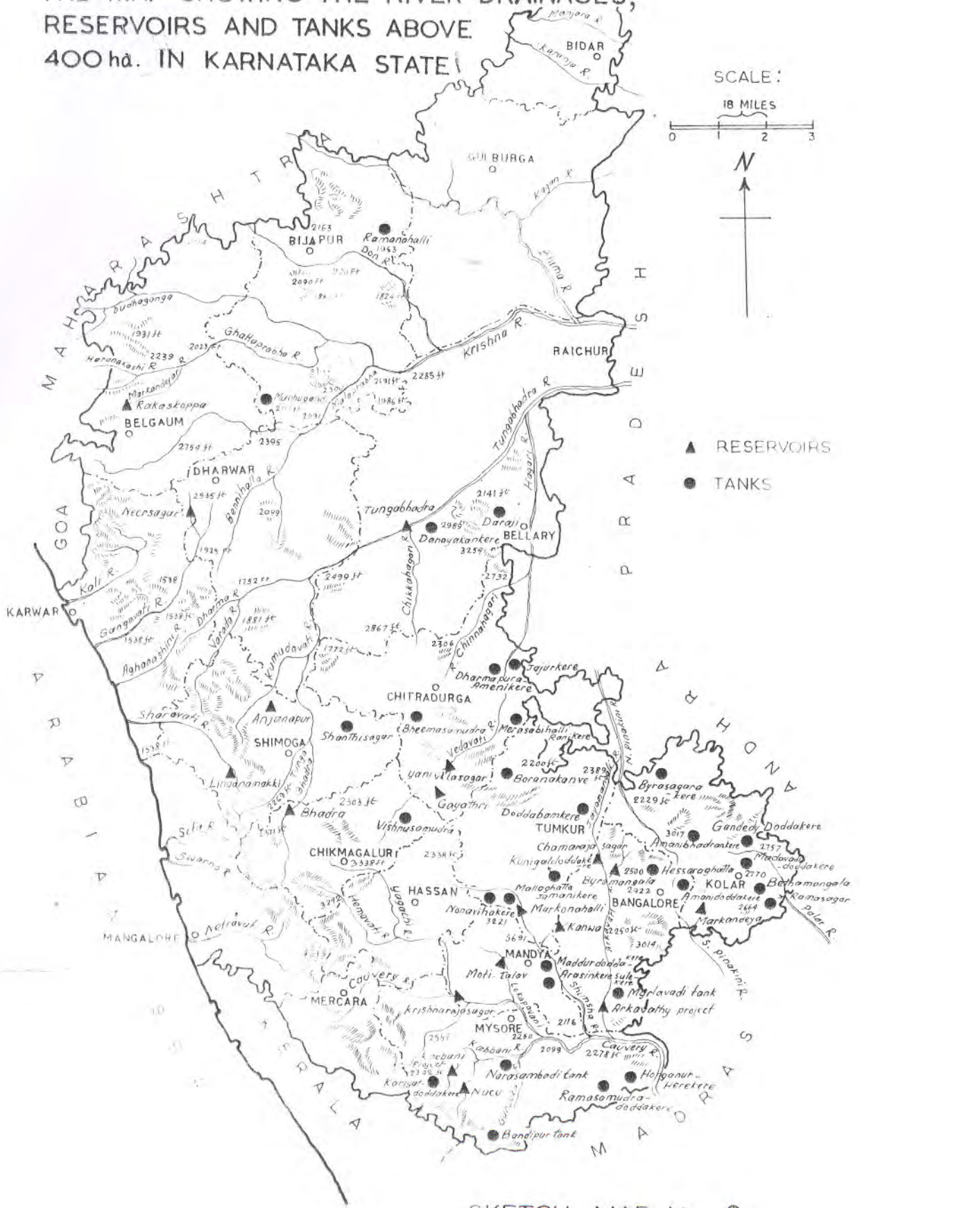
Problems and possible recommendations for development and investigations are mentioned based upon a coordinated study.

THE MAP INDICATING THE SOIL AND RAINFALL DIVISIONS IN KARNATAKA STATE



SKETCH MAP No. 1.

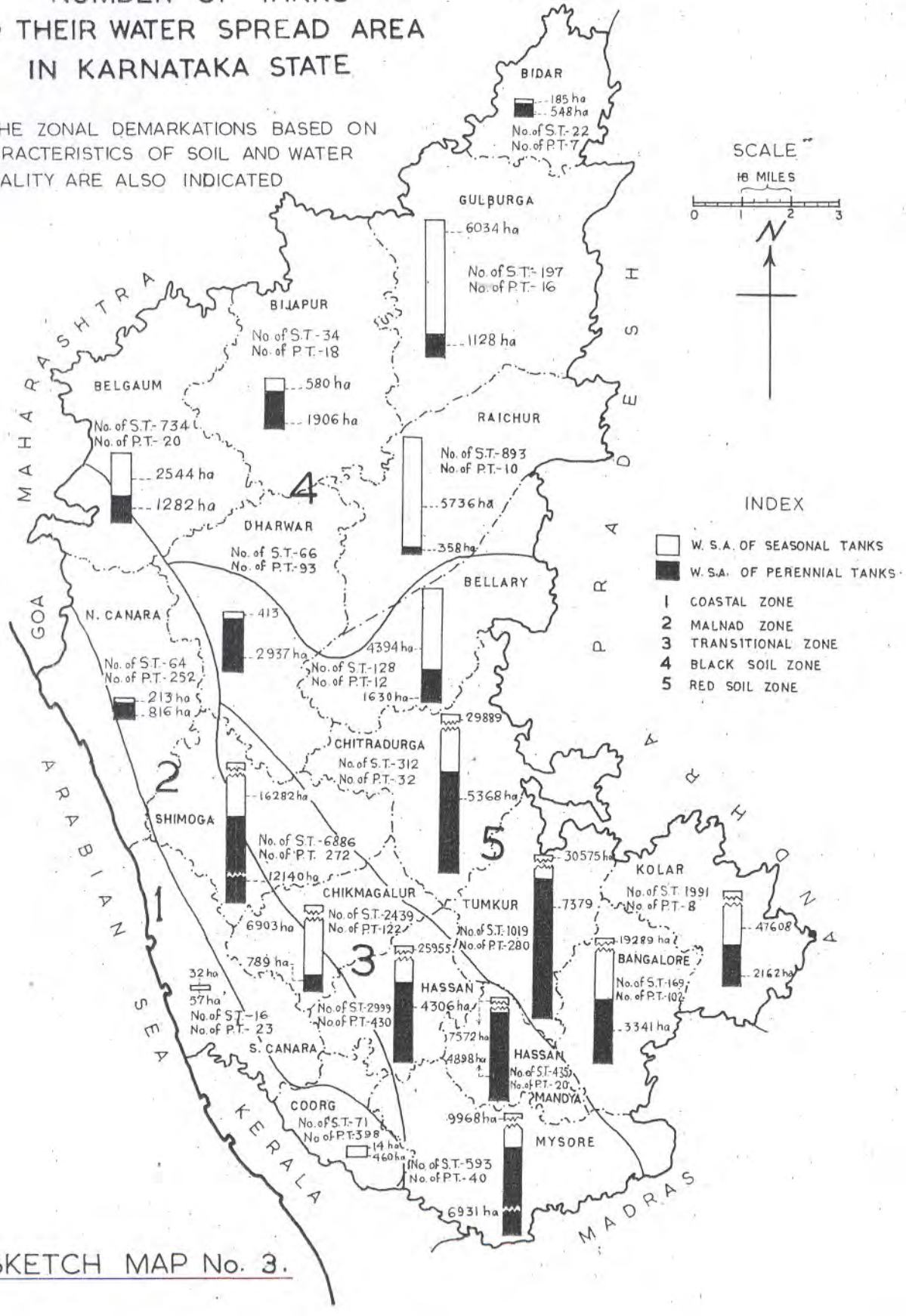
THE MAP SHOWING THE RIVER DRAINAGES, RESERVOIRS AND TANKS ABOVE 400 ha. IN KARNATAKA STATE



SKETCH MAP No. 2.

NUMBER OF TANKS AND THEIR WATER SPREAD AREA IN KARNATAKA STATE

THE ZONAL DEMARKATIONS BASED ON CHARACTERISTICS OF SOIL AND WATER QUALITY ARE ALSO INDICATED



SKETCH MAP No. 3.

PROFORMA - 1 A.

WATER IMPOUNDMENTS SURVEY

Perennial Tanks

Code No. (Hydrographical)

1. (i)

Date of Survey.....
Name of Tank.....
Ownership .....
Agency/Person holding
Fishing Rights .....

(ii)

District .....
C.D. Blocks .....
Taluks .....
Township/Village .....
Accessibility .....

Utility :

Irrigation ..... (How many hectares)
Bathing.....
Washing .....
Drinking .....
Temple .....

2. (i) Bank/Shore

	Length	% Perimeter	Total Perimeter
Abrupt			
Slope			

(ii)

Edged by	Length	Hight
Vegetation:		
Cultivated Fields :		
Weir/Waste Weir :		
Stone Work:		
Sand :		

(iii) Obstructions if any for fishing .....
.....

3. (i) Area (Hectares) of Water spread :

Estimated
By Records
By Enquiry
Maximum
Minimum

(ii) Shape :

Rectangular
Circular
Irregular
Others

contd.....

4. Soil Type

Alluvial
Black
Red
Laterite
Others

5. Bottom Type

Rocky	Silty
Rubble	Clay
Gracelly	Muck
Sandy	Marl

Remarks

.....
.....
.....
.....

6. Average Depts :

	At time of Survey	At full capacity	In summer
0-4 ft.			
4-6 ft.			
6-10 ft.			
10- ft.			

Q. Can Fishing be done easily ? .....
.....
.....

7. Source :

	Used by Fish for spawning/feeding/ Shelter/Migration	How used by Fishermen/ Villagers
Rain		
Canal		
Drain (Indicate if sewage or other wastes are led)		
Stream		
Overflow from an upper tank		

8. Outlets/Consumption :

Evaporation	How used by Fish/Escape Shelter/Feeding/Spawning	How used by Fishermen/ Villagers
Seepage		
Canal		
Drain		
Pipe		
Waste Weir		

Enumeretor Signature .....

Scrutinizers Signature .....

Proforma - 1 B.

WATER IMPOUNDMENTS SURVEY

Perennial Tanks

(Hydro Biological and Fish)

Code No.....

Name of Tank.....

1. (i) Water condition

	Remarks
Temperature	
Colour	
pH	
Turbidity	
D.O.	
Alkalinity	

(ii)

	Months
Duration of Turbidity	
Clear Water	

2. (i) Aquatic Vegetation

	Abundant	Frequent	Scarce
Bottom			
Submerged			
Floating			
Littoral			

(ii) Order of Abundance

1 .....

2 .....

3 .....

4 .....

5 .....

3. (i) Fish Food : .....

Q: Is it rich in Plankton ? .....
.....

Q: Is it rich in Bottom Biota ? .....
.....

(ii) Details of Manuring

Aquatic Insects:
Worms
Molluscs
Decaying Vegetation
Algae
Plankton
Others

contd.....

4. (i) Fishes :
(In order of abundance)

	Major carps	Cat Fishes	Weed Fishes	Miscell-aneous	Prawns
(ii) Predators	1	1	1	1	
.....	2	2	2	2	
.....	3	3	3	3	
	4	4	4	4	
	5	5	5	5	
	6	6	6	6	
	7	7	7	7	
	8	8	8	8	
			9		
			10		
			11		
			12		

(iii) Details of Stocking if any

Catla
Rohu
Mrigal
Others

(iv)

How Fished	Jan. May	Apr. June	July Sept.	Oct. Dec.
Traps				
Cast Nets				
Drag Nets				
Hook & Line				
Roiling				
Other methods				

(v) If not stocked, reasons ? .....
.....

contd.....

5. (i) Incidence of Mortality if any ? .....

.....

(ii) Diseases if any .....

.....

6. Catch : (i) Yield : Substistence Qty. Commercial Qty.

(ii) Disposal

	Regular	Weekly sporadic	Fresh.	Dried.
Local				
Out side				

Mode of Transport .....

7. Samples collected :

(a) Soil	No./Yes	Initials of the collector
(b) Water	No./Yes .....c.c	
(c) Plankton	No./Yes ..... litres	
(d) Biota	No./Yes	
(e) Fish	No./Yes ..... Qty.	

Enumeretor
Signature .....

Scrutinizers'
Signature .....

Proforma-2

WATER IMPOUNDMENTS SURVEY
SEASONAL TANKS

1.(i) Date of Survey .....

Name of Tank .....

Agency/Person Holding Fishing Rights

Utility :

Irrigation .....
(How many hectares)

Bathing/Washing/ Drinking.

(ii) District .....

C.D. Block .....

Taluk .....

Township/Village .....

.....

Accessibility .....

2.(i) Bank/Shore

Bank/Shore	% Perimeter	Total Perimeter
Abrupt		
Sloping		

(ii) Edged by :
Vegetation/Cultivated lands
Weir/Waste/Weir/Sand

3.(i) Area of water Spread :

Maximum	
At time of Survey	

(ii) Shape: Rectangular/ Circular
Irregular/Others

4. Soil Type : Alluvial/Black/Red/Laterite/Sand

5. Bottom Type : Rocky/Rubble/Gravell/Sandy/Silt/Clay/Muck.

6.(i) Depth: (Average)
Maximum
At time of survey

(ii) Impoundment Duration:
Between-
.....
Months
to.....
.....
Months

7. Source: Rain/Canal/Stream/Over flow from upper Tank.

8. Outlets: Evaporation/Seepage/Canal/Drain/Waste Weir.

9. Water Condition :

	Months
Turbid	
Clear	

10. Aquatic vegetation if any ; Bottom/Submerged/Floating/Littora.

11. Fish Food

Aquatic Insects
Worms
Decaying Vegetation
Algae
Plankton
Others

(a) Is it rich in plankton .....

(b) Is it rich in Bottom Biota

12. (i) Fishes: List in order of Abundance
1.
2.
3.
4.
5.

(a) Any Major Carps Available .....

(b) Predaceous Fishes .....

(c) Can Paddy cum Fish Culture be undertaken No./Yes ....
.....In .....
.....Months

(ii) Quantity Estimated Caught .....

(iii) Captural Technique .....

(iv) How Marketed .....(Months).....

13. Sample collected

(a) Plankton. No./Yes cc
(b) Fishes. No./Yes.....Qty

Enumerator's Signature

Scrutinizer's Signature