

INDIGENOUS KNOWLEDGE IN
MANAGEMENT OF MARINE
FISHERIES IN MAHARASHTRA

Thesis Submitted in Partial Fulfillment
of the Requirements for the Degree of

Ph. D. in Fish & Fisheries Science
(Fisheries Resource Management)

By

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(FRM-78)

Central Institute of Fisheries Education
(Deemed University)

Indian Council of Agricultural Research
Versova, Mumbai-400 061

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NOVEMBER 2001

..dedicated to my beloved
parents



Dated : 30 November 2001

CERTIFICATE

Certified that the thesis entitled “**INDIGENOUS KNOWLEDGE IN MANAGEMENT OF MARINE FISHERIES IN MAHARASHTRA**” is a record of independent bonafide work done by Mr. Vivek H. Nirmale during the period of study from September 1998 to November 2001 under our supervision and guidance for the degree of **Doctor of Philosophy in Fish and Fisheries Science (Fisheries Resource Management)** and that thesis has not previously formed the basis for the award of any degree, diploma, associateship, fellowship or any other similar title.

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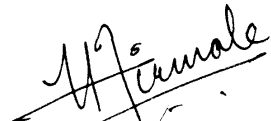
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I hereby declare that the thesis entitled “ **INDIGENOUS KNOWLEDGE IN MANAGEMENT OF MARINE FISHERIES OF MAHARASHTRA**” is an authentic record of the work done by me and that no part thereof has been presented for the award of any degree, diploma, associateship, fellowship or any other similar title.


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Uinayak
UINAYAK H. NIRMAL

सारांश

मात्स्यकी अनुसंधान का मुख्य उद्देश्य मात्स्यकी उत्पादन में वृद्धि करना है। प्राचीन प्रणाली में योजना कार्यक्रम तथा तकनीकी विकास प्रणाली में देशी ज्ञान का अभाव देखा गया है। मात्स्यकी विकास परियोजना में देशी ज्ञान एक मार्गदर्शक का कार्य करेगा व इसी के साथ ही मत्स्य समुदाय में आने वाली प्राथमिक समस्याएं भी सामने आएंगी। देशी ज्ञान का प्रलेख, संग्रहण तथा मान्यता आदि मात्स्यकी विकास का एक हिस्सा बनना चाहिए। ऊपर दिए गए सभी बातों को देखते हुए महाराष्ट्र के सिन्धुदुर्ग व मुंबई महानगर जिलों में मछुआरों के देशी ज्ञान पर एक अध्ययन किया गया। इस अध्ययन में अनुमानित नमूना पद्धति को दो तटीय जिलों तक ही सीमित रखा गया। इसमें दो जिलों के कुल 100 मछुआरों के मुख्यतः पारंपारिक मात्स्यकी पद्धति का अध्ययन किया गया। इस प्रयोगात्मक कार्य अध्ययन के लिए अन्वेषणात्मक सर्वे अनुसंधान का प्रयोग किया गया। आंकड़े इक्ठठा करने के लिए व्यक्तिगत साक्षात्कार तथा अवलोकन पद्धति आदि को अपनाया गया। इसमें बैग नेट, शोर सिन (तटीय जाल), गिल नेट, लाँग लाइन तथा परंपरागत ट्राल के प्रबंध से एवं मात्स्यकी आदि से संबंधित आई.टी.के. का अध्ययन किया गया। इस अध्ययन से यह निष्कर्ष निकलता है कि मात्स्यकी प्रबंधन पर कुछ आई.टी.के. की वैधता प्रमाणित होती है।

ABSTRACT

The major objective of fisheries research is to increase the fish production. The formal system is unable to incorporate indigenous knowledge in policies, programmes and technology development systems. The indigenous knowledge can provide guidelines for designing fisheries development projects that can emerge from priority problems within a fishing community. Documentation, compilation and validation of indigenous knowledge, thus, should become part of the developmental process aimed at sustainable fisheries development. The above objectives in view, the study was conducted to gain access to the indigenous knowledge of fishers of Greater Mumbai and Sindhudurg districts of Maharashtra. The study was restricted to two coastal districts selected using appropriate sampling procedure. A total of 100 fishers essentially practising traditional fishing methods representing the two districts constituted the sample for the study. Exploratory survey research design was employed for the study. Accordingly, a combination of personal interview and non-participant observation methods was used for data collection. The study documented rich, varied and potential ITKs (Indigenous Technical Know-how) associated with the management of bag net, shore seine, gill net, long line and traditional trawl fishery. The validity of a few ITKs on fishery management has also been established by the study.

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INTRODUCTION

1. INTRODUCTION

India has nearly 738400 fishers engaged in full time fishing operations. The country's Exclusive Economic Zone (EEZ) has an area about 2.02 million square km. The continental shelf area is approximately 0.5 million km². The potential yield from entire EEZ is placed at about nearly 3.9 million tonnes. The marine fish landings had varied between 2.692 million tonnes to 2.696 (1994-95 to 1998-99) million tonnes during the last five years (Department of Animal Husbandry and Dairying, Ministry of Agriculture, Government of India, 2000). Fishery resources within 50m depth have been fully exploited and there is concern that some resources may be overexploited. The population of India has already crossed one billion mark and is growing at the rate of 1.60% per annum. The major objective of fisheries research is to increase fish production to meet the food and nutritional demand of the ever-increasing population. A number of technologies were developed and are being developed to escalate the fish production, through various fisheries development programmes. The stagnancy in growth of marine fish production reveals the fact that inspite of various technologies, there is not much improvement in productivity.

There is an increasing pressure on government agencies to develop coastal management plans and on developers to use these plans in the design of sustainable management practices. Unfortunately, the implementation and success of such policies has been limited. This failure can be attributed to the fact that development efforts generally tend to ignore indigenous knowledge, local systems of knowledge and the local environment. Development programmes had always emphasized the use of modern scientific techniques. It is a fact that fishermen world over do use the traditional wisdom to solve some of their problems. Their knowledge of the ecology and behavior of fish (Johannes, 1981) of the weather and

oceanographic conditions, of navigation (Worsley, 1997) of fishing methods (Brandt, 1972) of vessel design and propulsion, of processing methods and trade, has been effectively used to overcome specific localized problems and to enable them to use local resources. Such indigenous technical knowledge (ITK) combines with traditional ecological knowledge (TEK) and fits within a wider social and cultural framework of knowledge to create what has been referred to as rural people's knowledge or RPK (Scoones and Thompson, 1997).

Rural people have an intimate knowledge of many aspects of their surroundings and their daily lives. Over centuries, people have learned how to grow food and to survive sometimes in difficult environments. They possess knowledge about what varieties of crops to plant, when to sow and weed, which plants are poisonous and which can be used for medicine, how to cure diseases, and how to maintain their environment in a state of equilibrium.

This indigenous knowledge or IK, covers a wide range of subjects such as agriculture, food preparation, education, institutional management, natural resource management, health care and many other subjects.

IK is a valuable resource for development. Under certain circumstances it can be equal to or even superior to the know-how introduced by modern research. Development efforts should, therefore, consider IK and use it to best advantage. Although more and more development professionals have come to realize the potential of IK, it remains a neglected field. A key reason for this is the lack of guidelines for recording and applying IK. Without such guidelines, there is a danger that IK will get eroded.

Indigenous knowledge (IK) refers to the unique, traditional, local knowledge existing within and developed around the specific conditions of women and men indigenous to a particular geographic area (Grenier, 1998).

The development of IK systems, covering all aspects of life, including management of natural resources has been a matter of survival to the people who generated these systems. It is based on experience, often tested over centuries of use, adapted to local culture and environment and dynamic and changing.

IK is stored in people's memories and activities and is expressed in the form of stories, songs, folklore, proverbs, dances, myths, cultural values, beliefs, rituals, community laws, local language and taxonomy, agricultural practices, equipment, materials, plant species and animal breeds. IK is shared and communicated orally, by specific examples and through culture. Indigenous forms of communication and organization are vital to local level decision making process and to the preservation, development and spread of IK. It may be noted that IK is not confined to tribal groups or the original inhabitants of an area. It is not even confined to rural people. Rather any community possesses indigenous knowledge - rural and urban, settled and nomadic, original inhabitants and migrants. Other names for indigenous knowledge (or closely related concepts) are 'local knowledge', 'indigenous technical knowledge', 'traditional knowledge' and traditional ecological knowledge.

In defining concept of IK, one must keep in mind the practical as well as the research needs. In general, indigenous knowledge is the participants' knowledge of temporal and social space. Indigenous knowledge as such refers not only to the knowledge of indigenous people, but to that of any other defined community. The concept of indigenous knowledge systems (IKS) delineates a cognitive structure in which theories and perceptions of nature and culture are conceptualized. Thus, it includes definitions, classifications and concepts of physical, natural, social and economic environments. To understand the indigenous practices one must have knowledge and understanding of the concepts on which they are based. This is particularly relevant in cases where intervention or improvement of

indigenous practices in changing ecological and economic scenarios is aimed at social sustainability.

Indigenous knowledge is often contradicted with scientific knowledge. Because indigenous knowledge changes over time, it is sometimes difficult to decide whether a technology or practice is really indigenous or adopted from outside, or a blend of local and introduced components. For a development project, however, it does not matter whether a practice is really indigenous or already mixed with outside knowledge. What is important is that instead of looking only for technologies and solutions from outside the community first look at what is in the community and then use knowledge, which is found to be more effective. It suggests that IK and modern knowledge need to fuse in terms of knowledge and practice.

There is an old African Proverb which goes: "When an old knowledgeable person dies, a whole library dies". The importance of IK is hidden in this proverb. Indigenous knowledge has two powerful advantages over outside knowledge - it has little or no cost and is readily available (Kothari, 1995). IK is found to be socially desirable, economically affordable, sustainable, and involve minimum risk to research users and widely believed to conserve resources. Thus, IK provides basis for problem solving strategies for local communities. In addition, the use of IK assures that the end user of specific development projects are involved in developing technologies appropriate to their needs (Warren, 1993) Learning from IK can improve understanding of local conditions and provide a productive context for activities designed to help the communities. Yet IK is still an underutilized resource in the development activities. It needs to be intensively and extensively studied and incorporated into formal research and extension practices in order to make rural development strategies more sustainable (Scoones and Thomson, 1994). Special efforts are needed to understand, document and disseminate IK for preservation, transfer or adoption elsewhere.

Identifying, documenting and incorporating IK in fisheries extension organization is essential to achieve sustainable development. IK systems provide a frame of reference for strengthening extension programmes. The participatory technologies that are developed through IK integration will

- (i) Provide diversified technological options, which enable users to choose using their own decision making systems.
- (ii) Originate from the user's own knowledge.
- (iii) Use of diversified sources in active participation of research minded users. Extension strategy should now focus on improving current benchmark of IK practices.

In fisheries there are at least four reasons why researchers, development workers and policy makers must understand and study extensively the indigenous knowledge shared by a particular fisher community. First indigenous knowledge constitutes a community's adaptation to its environment. Adaptation here means the way fisherfolk harness the resources of their environment in order to establish a viable relationship with it (Jocano and Velero, 1976). Second, according to Smith (1981), solutions to fisheries lie outside the sector. This assertion underscores the necessity of understanding the complexities of a fishing community before any intervention designed to uplift its standard of living is recommended and implemented. Third, within the context of common property like fishery it is important to identify the different groups that have stakes in changes that occur in institutional arrangements and access to the resources (Ruddle, 1988). Finally, fisheries management would benefit from fisher's time tested practices. Johannes (1981) stated, "Political, economic, cultural and social dimensions of a fishery severely restrict the effectiveness of management programs based solely on the biology of stocks". One must understand fish as well as fishermen. Understanding fishermen's customary practices of

resource allocation will help define the content in which biological information may best be employed in managing a fishery.

Thus, for sustainable commercial fisheries, a method must be found to blend together the traditional, time-honoured techniques and particularly those that ensure stability and sustained yield of artisanal capture fisheries with the needs and advantages of commercial fisheries. If planners would study traditional fishing communities they might conclude that perhaps the most important role they will play is in providing guidelines for design of small scale, highly adaptable and sustained technologies and techniques for fisheries. Local knowledge can be understood as a system of power and thus can provide a basis for the improvement of communities to undertake folk management. This is particularly important in tropical, multispecies fisheries and their environments on which the scientific knowledge is still relatively poor. The practical behavior oriented corpuses of local knowledge which focus on the most important species and their habits are of immediate value to fisheries planning, monitoring and management and to enforcement of regulations (Ruddle, 1991).

Further given the potential of traditional knowledge and management systems to help stem environmental and social degradation in the tropics, a program of appropriately designed research is of great interest to coastal management. An approach to coastal assessment that combines scientific and traditional knowledge has the potential to provide coastal managers with a local perspective that will augment any information base of a coastal area and will prepare them for sensitive issues that should be addressed through management. All this calls for concerted efforts to systematically document the indigenous knowledge in coastal fisheries and establish their scientific rationale.

Against this background the present investigation was carried out to explore the indigenous knowledge of coastal fisherfolk of Maharashtra. The investigation specifically focused on the following objectives.

- (i) To study the profile characteristics of respondents.
- (ii) To document the indigenous knowledge of coastal fishers about various aspects of fishery management.
- (iii) To analyze the fisher's rationale behind the use of the indigenous knowledge.
- (iv) To assess and validate the documented ITK's against the various criteria through fishery experts across the country.
- (v) To identify the problems faced by coastal fishers with respect to fishery management.

Scope of the study:

Present study emphasizes the documentation of indigenous knowledge related to various aspects of fishery management and establishing its rationale and validity. The indigenous knowledge of coastal fisherfolk has been evolved over a long period of time. This knowledge is rich and varied. The knowledge is well suited to the localities and is neither ignorant nor static. Indigenous knowledge is of great potential value. It can provide an important information base for local resources management especially in the tropics, where conventionally used data is usually from scarce to non-existent as well as providing a shortcut to pinpoint essential scientific research needs. To be useful for resources management, however it must be systematically collected and scientifically verified before being blended with complementary information derived from Western based sciences. In this regard it is hoped that results emerging from this study would be of immediate relevance and significance to policy makers, planners and Research and Development agencies, to reorient their programmes by evolving a mechanism to combine the indigenous and scientific knowledge in a synergistic way.

Limitations of the study:

The usual constraints of time and resources at the disposal of the single student researcher restricted the present study to the two districts of coastal Maharashtra. The data was collected from 100 randomly selected respondents from the two districts. Consequently the findings of the research cannot be generalized beyond the area studied and is thus not applicable to other coastal districts of Maharashtra.

REVIEW OF LITERATURE

2. REVIEW OF LITERATURE

Review of literature is an important aspect of any scientific endeavor as it helps the researcher to gain insight into the research problem and also to explore various procedures and methods to solve the same. In other words review of literature is a part of research planning process. This exercise also helps the researcher in relating the empirical findings or results of his/her research with those of previous studies. Keeping this in view efforts were made to review published literature in line with the objective of the present study. The reviewed literature is organized and presented under the following heads.

- 2.1 Concept of indigenous knowledge
- 2.2 Importance of indigenous knowledge
- 2.3 Indigenous knowledge on fisheries management
- 2.4 Dissemination of indigenous knowledge among fishers
- 2.5 Accessing the indigenous knowledge
- 2.6 Constraints in use and acceptance of indigenous knowledge

2.1 Concept of Indigenous Knowledge:

According to Farrington and Martin (1988), indigenous knowledge is based on knowledge, beliefs and customs that are internally consistent and logical to those holding them but at odds with objectively deduced findings of the formal science

Indigenous knowledge may be defined as the sum total of knowledge and practices, which are based on people's accumulated experience in dealing with situation, problems in various aspects of life and

such knowledge and practices, are special to a particular culture (Wang, 1989).

Knowledge which has been accumulated by the people over generations by observation, experimentation and by handling on old people's experience and wisdom in any particular area of human endeavor is termed as indigenous knowledge by Odhiambo (1990).

In the context of the marine environment, indigenous knowledge may be characterized as being based on detailed observations that tend to combine animal behavior and their interaction with the physical environment, practical in nature and dynamic, especially as these bodies interact with other epistemologies and world economic systems (Ruddle, 1994).

Agrawal (1995) made an attempt to compare and contrast indigenous knowledge and scientific knowledge. He noted similarities between the two in terms of intellectual process, organization, data acquisition, methods, concepts and goal while the differences between two were observed in terms of data sources, transmission, speed, methods, data type and analysis.

Indigenous knowledge refers to the unique, traditional, local knowledge existing within and developed around specific conditions of women and men indigenous to a particular geographic area (Grenier, 1998)

Indigenous knowledge is know-how and wisdom acquired through the observation of specific natural and social phenomena in combination with the experience of supernatural powers influencing life (Bharara, 1999).

The development of IK systems covering all aspects of life has been a matter of survival to the people who generated these systems. Such knowledge systems are cumulative, representing generations of experience and trial and error experiments.

Other names for indigenous knowledge (or closely related concepts) are "local knowledge", "indigenous technical knowledge", "traditional knowledge", "folk ethnology" and "traditional ecological knowledge".

2.2 Importance of Indigenous knowledge

Emmerson (1980) opined that only relatively recently has it been realized that "sea tenure" or the way in which fishermen perceive, define, delimit, "own" and defend their rights to inshore fishing ground exists at all.

Howes (1980) states that indigenous and scientific perspectives may diverge but both embody important insights thus suggesting desirability of synthesis. Such a synthesis would acknowledge the need for both diachronic data and synchronic data in the making of sound management practices.

Johannes (1980) stated that in the Pacific basin where scientific knowledge of the biology of seafood stocks and their environment lags well behind that available for temperate waters; indigenous knowledge can play an important role in marine resource management.

Nietschamann (1985) reported that local knowledge often includes a remarkably sophisticated and rich mental mapping system, which may include named features as small as larger individual coral heads.

Fishermen are more likely to comply with management measures when they are able to see the benefits which will rise from those measures and where they have been involved in formulation of measures (FAO, 1986).

Johannes and Hviding (1987) reported that the ability to monitor changes in fish stocks, to predict ecological consequences of intensified

resource exploitation and to suggest relevant new management measures are important aspects of Morovo people's traditional marine knowledge.

Farrington and Martin (1988) stated that participation is a useful device for strengthening and supplementing farmers knowledge system and their capacity to experiment on their account.

Johannes (1989) stated that the fishers of Oceania know far more about the local timings and locations of spawning aggregations than do marine biologists. He further stated that as they occur at predictable times and places, spawning aggregations provide excellent opportunities to monitor stocks. In addition they provide a useful focus for management because exceptionally large catches are made from them.

Kohnert and Weber (1990) proposed that one of the main tasks of research and extension service should be to support farmers experimentation in providing viable option, limiting risks, and analyzing and developing indigenous knowledge.

Biggelaar (1991) opined that the ultimate solution for rural development is not the dumping of more scientists upon rural people to make exogenously generated technologies more adaptable but to strengthen, empower and legitimize indigenous capacities for identifying problems and developing solutions for these problems. He further stated the "empowerment" of indigenous knowledge so that it has equal footing with Western knowledge may well be the most important step in a strategy of enabling the people in the developing countries themselves to alleviate their poverty.

Fals-Barda and Rahman (1991) stated that participatory researchers value the local knowledge of people but are aware of the dangers of romanticizing this knowledge.

Groenfeldt (1991) suggested that for reasons of environmental conservation as well as institutional stability, indigenous system should be

intelligently assisted rather than simply replaced. Realistically sustainable agricultural models that combine elements of both traditional and modern scientific knowledge need to be developed.

Marsden (1991) stated that community participation allows people to control their welfare by drawing on indigenous knowledge and familiar techniques as opposed to the extraneous control imposed on them by previous forms of intervention.

Wolfsohn (1991) emphasized the importance of using indigenous technical knowledge for developing national research management policy.

Woodley (1991) stated that the development process must be based on an understanding of traditional knowledge if projects are to be sustainable both environmentally and sociologically.

Ruddle *et al.*, (1992) stated that fishermen should be active participants in designing their own future since they generally have a much clear conception of some of the important constraints under which they operate.

Berkes and Gadgil (1993) stated that indigenous knowledge has been accumulated through a long series of observations transmitted from generation to generation and such "diachronic" observations can be of great value and complement the "synchronic" observations on which western science is based.

For DeWalt (1994), the synthesis of conventional science and local knowledge could lead to the development of "contextualized, holistic knowledge that can be adapted and applied to similar phenomena in other circumstances.

According to Dyer and McGoodwin (1994) interest in traditional management system stems from a number of benefits derived from their use.

By capitalizing on knowledge that already exists, redundancy is avoided. It can help to sensitize outside researchers to local conditions and concerns. When traditional systems have been overturned, capitalizing on their rather than inventing another perhaps misinterpreted management system may be accepted more readily by local people.

Traditional knowledge evolved over generations of direct interaction between human communities and their environment are likely to contain ideas and information not currently contained within Scientific models (Lalonde and Akhtar, 1994).

Agrawal (1995) reported that to productively engage indigenous knowledge in development, we must go beyond the dichotomy of indigenous vs. scientific and work towards greater autonomy for 'indigenous people'.

Chambers (1995) says determination of priorities in fisheries should be much more by and through analysis and experience of local people, weighted to give voice to women, weak and poor people.

The indigenous knowledge is often of great significance to the communities concerned and is essential for their livelihoods and the sustainable use of resources (Mulipola *et al.*, 1995).

Roy (1995) opined that a scientist and a fisher can discuss a concept like maximum sustainable yield as need to declare a closed season in spawning areas during particular seasons only if they understand each other's perception of the eco-system and logic frames. He further stated that fishers should be assisted to organize themselves and be empowered further by government by giving them control and use-rights over the resources they have relied on for their livelihood security for generations.

Christie and White (1997) stated that the use of traditional knowledge has the potential to facilitate participation of local people in a planning process and therefore contribute to local empowerment.

Local knowledge, combined with specialized knowledge of the outside researcher is considered by advocates of participatory research (PAR) to be more potent than either knowledge alone in understanding reality (Christie and White, 1997).

McClanaban *et al.* (1997) opined that many traditions of coastal peoples may be viewed as traditional forms of marine conservation because like modern fisheries management they restrict fishing gear, fishing times and places but their effects are little studied in practice.

Neis (1997) opined that gathering the ecological knowledge of fishers could add dramatically to the often-impoverished understanding of marine eco-systems. Although not necessarily developed to meet explicit conservation goals, local management systems often work more effectively than those introduced through colonization and government initiatives.

Fishers have considerable knowledge about the social, cultural and institutional arrangements within their communities, how resources are allocated, how conflicts are avoided or resolved. This information can be useful for designing sustainable development interventions (Geoghegan and Smith, 1998).

Many subsistence fishers in tropical regions live in discrete communities that have some degree of control, either legal or traditional of adjacent waters. These factors provide an ideal basis for communities to be assisted to manage their marine resources (King and Faasili, 1998).

Ruddle *et al.* (1992) reported that the fishers of Maravo Lagoon, Solomon Islands possess local knowledge of natural processes and regular occurrences such as growth rates of important shells and spawning aggregations of important food fishes. This informs decisions made by managers of different corporate descent groups about fishery management measures and their enforcement.

Salas *et al.* (1998) reported the potential of integrating traditional environmental knowledge of local people in ecosystem modeling.

Smith (1998) opined that traditional fishery practices and local knowledge of fish identification and ecology could provide convenient and cost effective methods for monitoring artisanal fisheries. The open-water seine-net ("Chirimala") fishery of Chembe village in Lake Malawi National Park, Malawi, Africa was monitored with methods based on local fish measurement and preservation and identification practices.

Hamilton (1999) examined local knowledge of aggregating behaviors of the carangidae in a confined part of the Roviana Lagoon, Western Province, Solomon Islands. In the study, detailed ethnographic data on carangidae behavior are collected from local informants through interview and participant observation. This information served as a basis for designing hypotheses on the tidal movements and aggregating behaviors of Carangidae within Roviana Lagoon, which were then tested using scientific field observations.

2.3 Indigenous Knowledge on Fisheries Management:

Most of the indigenous knowledge has been demonstrated for agriculture, animal husbandry, forestry and agro-forestry, ethnomedicine, technology and biological, physical and geographical phenomena (Thrupp, 1988; Warren, 1993).

No systematic studies of comparable scope have been made in fishing communities. However, local knowledge in fishing communities, although not assessed in management terms has been described in the Pacific Basin from Malaita, Solomon Islands (Akimichi, 1978); Palau, Micronesia (Johannes, 1981) and the Torres Strait Islands, Australia (Nietschmann, 1989), as well as in Brazil (Forman, 1967; Cordell, 1974, 1978), Virgin Islands (Morrill, 1967) and in India (Raychaudhuri, 1980).

The rich and ancient Hindu knowledge of fish, was first documented during the period 600-300 B.C. (Hora 1935, 1948, 1952, 1953) and was strongly associated with both explicit and implicit regulations for fish management and conservation (Hora 1948, 1953). In the regulations for the "Superintendent of Slaughter Houses" (Book II, Ch.24 of the *Arthashastra* of Kautilya, the earliest known dated work of the ancient Hindus written in the period 321-300 B.C. punishments and monetary fines were specified for persons who entrapped, killed or molested fish (Hora, 1948). Similarly the *Vishnu Dharmasutra* states that even unintentional killing of fish must be atoned by three days of fasting, "suitable penances" or fines (Hora, 1953).

Morill (1967) observed that Cha-Cha of the Virgin Islands in the Caribbean were "conversational monomaniacs fixated on fish", for whom fish behavior was a subject of supreme interest, taking the form of descriptions of observed behavior, explanations for the behaviors, fish feeding behavior and to a lesser extent reproduction, territoriality and the "personality of species and individuals". Pelagic fishes are thought to breed after large-scale weather changes whereas neritic fishes are believed to breed according to moon phase at any time of the year.

According to McCoy (1974) due to dwindling reef fish populations on Satawal Island in the Central Caroline Islands of Micronesia, fishing of one reef section was prohibited by taboo in order to provide a breeding ground to supply the rest of the reef and the area was fished on authorized days only, which amounted to just five during a three year period.

Johannes (1978) reported that in Oceania several types of marine resource conservation might have been traditionally consciously employed to ensure sustained yields. Among these were the live storage or freeing of surplus fish caught during spawning migrations, the use of closed seasons, the placing of taboos on fishing areas, the reservation of particular areas for fishing during bad weather and size restrictions. Others, many of which were related to traditional religious beliefs also functioned coincidentally as conservation devices.

Raychaudhuri (1980) describes how the fishers of Jambudwip, India, coordinate the complex variables of seabed topography, seawater conditions and sequences of tide and ebb with fish behavior to ensure both successful catches and their own safety at sea. In their selection of the appropriate seabed over which to conduct their activities, these fishers are like the agriculturists who tend to classify the soil according to its relative fertility and types of crops grown.

Johannes (1981) reported that in Palau different size classes are distinguished in indigenous taxonomies either because of their different habits or habits or because of the different fishing techniques used to take them. For example, the milkfish (*Chanos chanos*) is known as *Chaol* when it is small and lives in brackish mangrove ponds and as *mesekekat* after it has grown larger and moved to the reef over sandy bottoms.

Gaigo (1982) reported that in Tatana village, Papua New Guinea, the fishers collected dead fish from the sea for burial on land to protect their fishing ground from pollution and from the big and dangerous fish that may be attracted to their fishing areas.

Johannes (1982) reported that fishing communities are often repositories of valuable traditional knowledge concerning fish stocks and have a high level of awareness of the marine environment.

Traditional conservation ethics and management practices provide a locally sanctioned code of behavior that can be harnessed to further the objectives of modern marine resource management (McGoodwin, 1984).

Smith (1985) documented the marine fishing and hunting practices of the Hopevale aboriginal community, acquired indigenous knowledge of the biology and behavior of tropical marine food resources of Great Barrier Reef Marine Park. This knowledge provided recommendations that could be used in the development of a management programme.

Torres Strait Islanders refer to a taxonomy of more than eighty distinct terms to describe different tides and tidal conditions, using a "Lunar-based system that keeps track of the four daily tides, changes in height and current speed, time of occurrence and duration, seasonal shift, water clarity, surface conditions and associated movements of fish". (Neitschmann, 1989)

According to Ruddle (1989) throughout the tropics prime spots where predictable aggregations of important food species occur are known to local fishers and for such spots, knowledge of the timing and location of fish aggregations is capture oriented, highly prized and often jealously guarded.

Veitayaki (1990) reported that in Fiji, the sacred fishing grounds were special areas where rules strictly adhere to. At such sites fishing was conducted only when the traditional priest granted permission.

Veitayaki (1990) reported that in Qoma, the fishers would abandon their nets and run away if their totem fish was caught. The practice limits the catching effort and contributes to the maintenance of the stock.

Ruddle (1991) reported that in coastal communities, bodies of indigenous knowledge are empirically based and practically oriented. He stated that most combine information on fish behavior, marine physical environments, fish habitats and interactions among the components of ecosystems. This knowledge functions to ensure the sustainable utilization of aquatic resources, and provide an important information base for local resource management especially in the tropics where conventionally used data are usually scarce to non-existent, as well as providing a shortcut to pinpoint essential scientific research needs.

Toloa *et al.* (1991) reported three types of traditional marine conservation measures distinguished for Tokalau in the South Pacific. These are specific measures, indirect measures and the perfection of nondestructive fishing techniques. The *Lafu*, or fishing taboo is invoked by Council of elders and results in a ban on all fishing in specific areas on the

main reef other such measures are the return to the sea of undersized fish and the ban on fishing using beche-de-mer toxins which are known to damage corals. The perfection of nondestructive fishing techniques and skills are transmitted during the many years of training of a *tautal* (specialist) who uses only the "proper" fishing techniques rather than those that give the best results.

Hores (1992) described the lasting effects in involving the fisherfolk in managing their own resources using the knowledge they learned through years of experience combined with new technology introduced by educational institution, in Baliscasag Island in Philippines. With minimal effect of legislation in conserving natural resources, government has turned to the users for assistance in the management of resources by what is now popularly known as "community based resource management".

Johnson (1992) examines the process of collecting TEK while using a participatory action or community based approach. It looks at the problems associated with documenting TEK and explores some of the means by which TEK can be integrated with Western Science to improve methods of natural resource management.

Neitland (1993) reported that traditional systems using indigenous knowledge has been very successful in controlling resource exploitation within the dynamic and complex environment of the Sahel Savanna region in N.E. Nigeria.

Farmers' practice harvesting crabs from the bunds of rice fields in rice-based farming systems in South India. Local people have in depth knowledge of the crabs and their ecology. Certain socio-cultural factors influence catching and consumption of crabs (Rajsekaran and Whiteford, 1993).

Fong (1994) described customary fisheries management practices in Fiji and in particular in the four administrative districts of Drekatu,

Macuata, Sasa and Matta. He has discussed the traditional fisheries knowledge among Sasa and Navakasabu fishers. Use the possibility of giving legal effect to such traditional measures is considered.

Siar *et al.*(1994) documented the indigenous knowledge of fishers in Malalison Island located in Panay Island, Central Phillipines. Side reported that to be able to mark their fishing areas, islanders use palangat, a system of triangulation using landmarks as points of reference. Siar also reported that a coral reef or fishing area is differentiated from one another by its name, which is usually derived from landmarks.

Entsua-Mensah and Dankwa (1997) reported that a survey was carried out in 20 lagoons in Ghana to compile the various traditional management practices of the fisherfolk living around the lagoons in Ghana and also reported that the taboos help in management of fishery resources in the lagoons.

Tonga *et al.* (1998) reported local marine knowledge and subsistence fishing practices of fishers in Idihifo village on Lifuka island in the Ida'apai group in the Kingdom of Tonga. He also reported the fishers follow many traditional practices and retain rich natural history knowledge of the movements and behavior of many species of fish.

Indigenous knowledge includes empirical and practical components, which are fundamental to sustainable resource management. Among coastal - marine fishers regular catches and often long term resource sustainment are ensured through the application of knowledge that encompasses empirical information on fish behavior, marine physical environments, fish habitats and the interactions among ecosystem components as well as complex fish taxonomies. Local knowledge is therefore an important cultural resource that guides and sustains the operation of customary management systems. The sets of rules that compose a fisheries management system derive directly from local concepts and knowledge of the resources on which the fishery is based.

2.4 Dissemination of Indigenous Knowledge among fishers:

The transmission of local knowledge is a critical process of education in any society.

In some small scale fishing societies, knowledge is or was transmitted via formal apprenticeship system. For example, canoe fishers in Bahia, north-eastern Brazil, pass on their knowledge through a limited number of apprenticeships that can last for as long as ten to fifteen years (Cordell, 1990).

Ruddle and Chesterfield (1977) stated that on the island of Guara, in the Orinoco delta of Venezuela children are educated in traditional food procurements tasks via a sequential, additive and highly structured curriculum. The system is highly structured and systematic. Emphasis is placed on learning by doing through repeated practice over time. A teacher's first step is to familiarize the learner verbally and visually with the physical elements of the appropriate location. The entire complex is demonstrated over a period of time proceeding additively and sequentially.

A striking contrast is found on Pukapuka, Cook Islands of Polynesia where much of the corpus of local knowledge is transmitted informally (Brofosky, 1987). Verbal instruction is rare; both children and adult learn mainly by observation, followed later by imitation. Formal instruction is minimal and questioning especially by children is discouraged.

Transmission of indigenous knowledge among fishers in a coastal community is mainly through observation and experience.

2.5 Accessing the IK :

Howes (1980) stated that elders represent sources of knowledge of change over time, due to length of their personal experiences in natural settings.

Howes and Chambers (1980) argue that one of the best methods for gaining access to IK, is for government personnel to work alongside local harvesters/workers.

Brody (1988) stated mapping exercises as one of the IK accessing methods.

Natural scientists must work with social scientists to ensure ecological information provided by IK holders is properly understood (Johnson, 1992).

Eythorsson (1993) argues that elders develop cognitive maps of areas used for resource extraction and other activities, which in the case of Sami Fjord fishers include even the topography of the ocean floor.

Johannes (1993) identifies four areas of focus for IK research:

- (i) Taxonomic: Learning local names for animal, plant, soil and rock taxons. This helps to lessen the danger of overlooking the importance of certain ecosystem components such as food, medicine, structural material, tools, totems, etc. when making management decisions.
- (ii) Spatial: Identifying aggregation sites, migration routes, etc. In this regard mapping exercises involving local people are more productive than inventories done by outside researchers.
- (iii) Temporal: Determining the timing of certain significant biological events including site aggregations and spawning activity.
- (iv) Social: Studying the way local peoples "Perceive" use, allocate, transfer and manage their natural resources.

Mailhot (1993) reported that methods for accessing IK include discourse analysis, formal eliciting, and semi-directed interviews.

DeWalt (1994) stated that in order to access IK in local communities they may need to employ social scientists (anthropologists, social planners, sociologists, geographers, etc.) with an expertise in social and political content to act as intermediaries.

There is also need for cultural sensitivity and language training for scientific researchers (Johnson, 1992; Spak, 1995) along with scientific training for local people (Weeks and Packard, 1997).

Gaining access to Indigenous Knowledge in order to input it into management systems is one of the crucial tasks. Cost effective and efficient ways should be followed to access the indigenous knowledge in a fishing community before it disappears.

2.6 Constraints in use and acceptance of indigenous knowledge

Despite the apparent richness and usefulness of traditional knowledge systems they are rapidly disappearing. Colonization, market penetration, global advertising for material goods, poverty, population growth all are contributing factors.

Chambers (1980) reported that it is difficult for some professions to accept that they have anything to learn from rural people or to recognize that there is a parallel system of knowledge to their own which is complementary, usually valid and in some respects superior.

Johannes (1981) reported that in Palau, fishers began to abandon their traditional management schemes to trade with Japanese colonists and the US administration in 1940s.

Dahl (1989) reported that in New Caledonia the processes of discrediting localized knowledge of resources has been going on for generations among European colonists administrators, educators and missionaries.

Johannes (1989) reported that local people's beliefs are erroneous on occasion and do not necessarily lead to sustainable resource management.

Kottak (1992) reported increased efficiency of resource exploitation with new technologies due to market penetration in Brazil.

Ruddle *et al.* (1992) reported that the romantic and uncritical espousal of indigenous knowledge and management is an extreme almost as unfortunate as that of dismissing it.

Christie *et al.* (1994) reported that poor Filipino fishers in debt to exporters have been driven to use sodium cyanide for aquarium fish gathering.

Samarakoon and van Zon (1996) stated that the tension between the desire by some for nation building with centralized planning and others who prefer traditional systems based on local control as the most important issue blocking the appropriate use and acceptance of traditional management system.

Christie and White (1997) reported that traditional knowledge continues to be ignored by some researchers, because its discovery and analysis require in-depth sociologic, economic and anthropologic observations, which are often difficult and time consuming. They further stated that professional also ignore traditional knowledge because they cannot discredit the knowledge on which their education and careers are based by going outside of their expertise.

Grenier (1998) states that all knowledge systems have their limitations and weaknesses and IK is no exception.

Kottak (1992) stated that traditional knowledge may be exaggerated as in case of the supposed ability of Brazilian fishers to be able to memorize and exactly locate hundreds of fishing spots in the open ocean.

Townsley (1998) reported that in some cases people's knowledge might be simplistic and relatively poor.

Johannes (1993) reported that traditional environmental knowledge could also be invaluable in environmental impact assessment in coastal areas.

Professionals also ignore traditional knowledge because by going outside their research, they may be discrediting the system of knowledge on which their education and careers are based. (Christie and White, 1997).

Summary

Indigenous knowledge is the knowledge people in a given community and geographic area have gathered over the years by wisdom, experience and experimentation and has been a matter of survival for them. Transmission of indigenous knowledge among fishers in a coastal community is mainly through observation and experience, and can be accessed through discourse analysis, formal eliciting, semi-directed interviews and working alongside local harvesters / workers. Coastal fishers apply indigenous knowledge on fish behavior, marine physical environments, fish habitats and the interactions among ecosystem components and fish taxonomies to ensure regular catches and often long-term resource sustainability. Documentation, compilation and legitimization of indigenous knowledge should become part of development process aimed at sustainable fisheries development, which assures that the end user of specific development projects are involved in developing technologies appropriate to their needs.

RESEARCH METHODOLOGY

3. RESEARCH METHODOLOGY

The present study was carried out during the year 1999 – 2000. The general typology and description of various research methods and procedures employed for sampling, data collection and analysis are outlined under the following major heads

- 3.1 Locale of the study
- 3.2 Research design
- 3.3 Sampling procedure
- 3.4 Brief description of study locale
- 3.5 Operationalization and empirical measurement of concepts
- 3.6 Assessment of indigenous technical know-how.
- 3.7 Tools and methods of data collection

3.1 Locale of the study:

For any social research involving workers as the unit of study, direct communication between the researcher and the respondents is essential to ensure free and frank expression of responses. The present study was carried out in the Maharashtra State. In view of the limited time and other resources at the disposal of the researcher, the study was further restricted to only two of the five coastal districts of Maharashtra.

3.2 Research design:

The main focus of the study was to document and validate the indigenous technical know-how of coastal fisherfolk on various aspects of fishery management. Keeping in view the nature and requirement of data for the study, exploratory survey research design was considered most appropriate and was used with necessary operational modifications.

3.3 Sampling procedure:

Considering the nature and magnitude of data requirements of the study, two districts, viz., Greater Mumbai and Sindhudurg were selected to represent northern and southern coastal Maharashtra respectively. Random sampling procedure was used to select villages and respondents. Table 1 gives an account of the sampling plan used in the study.

3.3.1 Selection of state:

Maharashtra State was selected for the study due to the following reasons:

- i) It is one of the leading maritime state with second largest coast line in the country
- ii) It has good potential for fisheries development
- iii) The researcher is a native of this state and is well versed with the ethno-cultural life of fishermen of the state

3.3.2 Selection of districts:

Maharashtra has five coastal districts namely, Thane, Greater Mumbai, Ratnagiri, Raigad and Sindhudurg. Of these, Greater Mumbai and Sindhudurg were selected for the study owing to the following reasons:

- i) Limited time and resources available to the researcher.
- ii) The two districts represent the north and south regions of coastal Maharashtra.
- iii) Diversity in terms of fishing crafts, gears and fish catch.

3.3.3 Selection of villages:

Five fishing villages in each district were selected randomly for the purpose of collecting data for the study. Thus, ten fishing villages from both districts were selected.

Five fishing villages selected from Mumbai district were Malwani, Erangalbhati, Khardanda, Sasoon Dock and Jamshedji Bunder. While five fishing villages selected from Sindhudurg district were Deobag, Tarkarli, Dhuriwada, Makarebag and Dandi.

3.3.4 Selection of respondents:

From each of the selected villages, ten fishermen who were resorting to traditional fishing practices were randomly selected as respondents for the study. Thus, a total of 100 fishermen representing ten fishing villages spread over two coastal districts constituted the sample of respondents for the study.

3.4 Brief description of study locale:

The study locale indicating the state, districts and villages selected is depicted in figure 1.

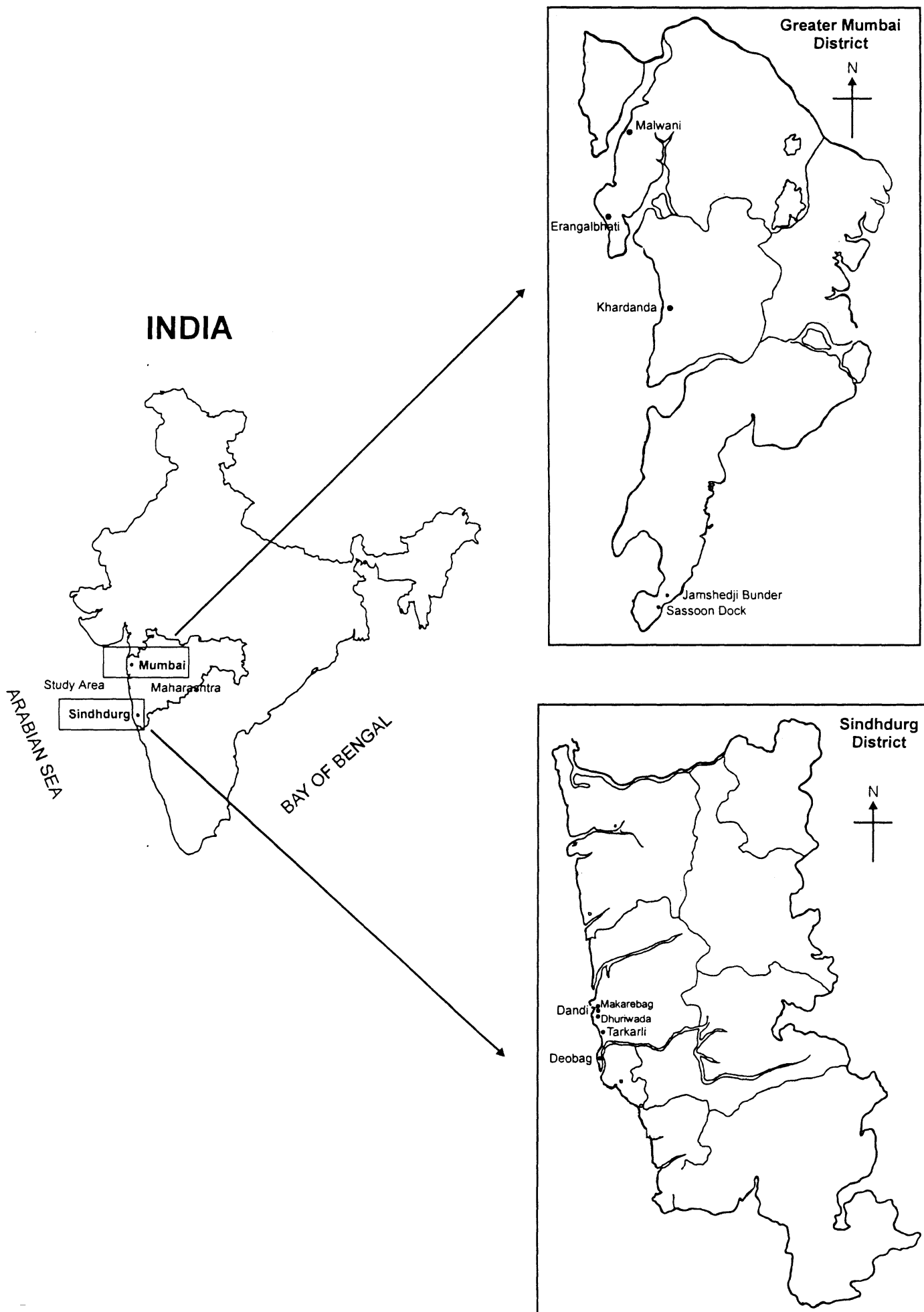
Study state:

Maharashtra, the second largest state in the country in terms of area appears as a huge irregular triangle with its base on the western coast of the country facing the Arabian Sea. The geographic location of state is 16.42 N latitude and 76.00 E longitudes. The coastal region popularly known as Konkan is about 720 km in length and 80 km in breadth. On the eastern side the Sahyadris or the Western Ghats run parallel to the coastal region. The state covers an area of 807690 km² with a population of 789 lakh. The state has 35 districts of which Thane, Mumbai, Raigad, Ratnagiri and Sindhudurg come under the coastal region. The population density of the state according to the 1991 census is 256 persons per km². Maharashtra accounts for 9.2% of the total population of the country. The total literacy rate is 68.30%; males accounted for 74.80% and females 50.50%.

Table 1 : Sampling plan

Unit sampled		Procedure
Unit	Place/fishers selected	
<i>State</i>	Maharashtra	
<i>Districts</i>	1. Greater Mumbai 2. Sindhudurg	Selected to represent northern and southern coastal Maharashtra respectively.
<i>Villages</i>	Greater Mumbai i) Malwani ii) Erangalbhati iii) Khardanda iv) Sassoon Dock v) Jamshedji Bunder Sindhudurg i) Deobag ii) Tarkarli iii) Dhuriwada iv) Makarebag v) Dandi	Random sampling
<i>Fishers</i>	Ten from each selected village	Random sampling

Figure 1
Study locale depicting the state, districts & villages



The state has a vast coastline of 720 km and continental shelf area over 0.11 million-sq. km. that offers rich resources for the marine fish production in the state. The state has a total no. 184 landing centers and 395 fishing villages. The state is endowed with rich fish and crustacean fauna comprising pomfrets, prawns, Bombay duck, mackerel and ribbonfishes. The state contributes 15% of the total marine production of the country (520380 tonnes) and stands third in marine fish production. The foreign exchange earnings from the export of marine products from the state have reached a peak of about Rs.750 crores. (Anon, 2000).

The total fishermen population engaged in fishing directly or indirectly is over 0.3 million. Besides this, over 0.2 million people get employment in the ancillary activities connected with fisheries. As of today there are about 20,000 boats including 10,000 motorized and mechanized boats resulting in decrease in the per unit catch. (Anon, 2000).

Districts studied:

GREATER MUMBAI

Greater Mumbai district is geographically situated at 18.53 N latitude and 72.54 E longitudes and has a coastline of 80 kms with a continental shelf area of 2,800 km². Mumbai is the major industrial hub of the country. There are 23 coastal fishing villages in the district, and two fishing harbors. The fishermen population of the district is 34,580 out of which 4023 fishermen are active (Department of Fisheries, Maharashtra, 1999). There are 1547 motorized fishing crafts and 1011 non-motorized fishing crafts in the district. The geographical area is 603 km². The per capita income (at current prices) is around Rs.6218. The estimated annual marine fish landing of the district was 1,40,119 tonnes during the 1997-98 contributing about 30.9% to total marine fish production of the state.

SINDHUDURG

This district is geographically situated at 15.37° to 16.40° NW longitudes and 72.13° to 74.13° EW latitude. It has a coastline of 121 kms and continental shelf area of 16,000 km². The fisheries and ancillary activities connected with it form an important part of the district's economy. Other important sources of income are various crop plantations such as mango, cashew, coconut trees, betel nut, palm etc. Rice farming is also common. Thus the district has good horticulture potential, and offers excellent prospects for horticulture-based industries. The per capita income of the people at current prices is around Rs. 2,709.

The district has eight main landing centers and 76 coastal fishing villages. The fishermen population of the district is 24,829 out of which 4,278 are active. The fish production of the district during 1997-98 was 34,824 metric tonnes, contributing about 7.7% to total marine production of state.

The number of motorized fishing crafts in Sindhudurg is 1177 while non-motorized fishing crafts numbered 1781.

Study villages:

Malwani village is adjacent to village Marve to its north side and has a fishermen population of 576. There are about 238 active fishermen. There are 58 mechanized boats and 18 non-motorised boats. Operation of bag net and gill nets forms important fishing activities.

The village **Erangalbhati** is situated north of Madh Island in Mumbai. It is small fishing village characterized by dol net fishing. The fishermen population of Erangalbhati is 363 out of which 123 are active. There are 102 mechanized boats and 20 non-motorised boats.

Khardanda fishing village is situated at about one kilometer distance from Khar railway station on its west side. It has fishermen

population of 1141 out of which 285 are active. It has got 81 mechanized boats and 57 dug out canoes. Operation of traditional trawl and bagnet is carried out mainly.

Sassoon Dock is important landing center in Mumbai. It is also known as Lower Colaba. It is situated in South Mumbai. Fishermen operating trawlers and purse-seiners from Raigad as well Ratnagiri land their catch in Sassoon Dock. There are 841 fishermen in its locality out of which 207 are active. There are 51 mechanised boats and 20 dugout canoes. **Jumshedji Bunder** is a small fishing village situated between Sassoon Dock and Gateway of India, where fishers mainly operate bagnets.

The above fishing villages of Greater Mumbai district have somewhat irregular coastline. The currents are swift and ideal for operating bagnets.

Deobag village in Sindhudurg district has typical geographic location. It is flanked on one side by Tarkarli creek while on the other by Arabian Sea as it is projected into sea. The fishermen population of the village is 1,261. There are 31 motorized and 128 non-motorised fishing crafts. Shore-seines and gillnetting are important types of fishery.

Tarkarli village is situated nearby Malwan town. The village has fishermen population of 831. There are 36 motorised and 106 non-motorised fishing crafts.

Dhuriwada village is situated within Malwan town. The village has fishermen population of 426. There are 35 motorised and 10 non-motorised fishing crafts.

Makarebag village has fishermen population of 350. The number of motorised fishing crafts is 40 while non-motorised fishing crafts numbered 9. It is also situated within Malwan township limit.

Dandi village also forms part of Malwan town. The village has fishermen population of 738. There are 72 motorised and 50 non-motorised boats.

All the above fishing villages of Sindhudurg district are located along the sandy shores of the Malwan coast and are ideal for the operation of shore-seine.

3.5 Operationalization and empirical measurement of concepts:

3.5.1 Profile characteristics:

Keeping in view the objectives set for the study, it was felt necessary to describe the respondents in terms of a set of profile characteristics. To this extent a set of seven attributes were identified based on review of literature and discussion with experts (Table 2).

Operationalization and measurement of the selected characteristics is outlined below:

3.5.1.1 Age:

It referred to the chronological age of the respondents in completed years at the time of investigation. On the basis of age, respondents were grouped into three categories as indicated below.

Young	-	upto 30 years
Middle	-	between 30 to 50 years
Old	-	above 50 years

3.5.1.2 Marital status:

It referred to the marital status of the respondents in terms of unmarried or married and the responses were grouped accordingly.

3.5.1.3 Education:

It referred to the academic qualifications of the respondents, acquired through formal schooling and non-formal methods. The respondents were grouped as illiterate, read only, read and write, primary school, high school and college.

Table 2 : Profile characteristics and their measurements.

Sl.No.	Variables	Measurements
1.	Age	Direct questioning
2.	Marital status	Direct questioning
3.	Education	Direct questioning
4.	Experience	Direct questioning
5.	Size of family	Direct questioning
6.	Type of house	Direct questioning
7.	Type of family	Direct questioning

3.5.1.4 Experience:

Experience referred to the number of years spent by the respondent in the fishing activity. Respondents were classified as under:

Less	-	Upto 10 years
Moderate	-	10 to 20 years
More	-	Above 20 years

3.5.1.5 Size of family:

It referred to the number of members in a fisher household. Respondents were classified as having small and large family.

Small	-	Less than 4
Large	-	More than 4

3.5.1.6 Type of house owned:

It referred to the place of fisher's dwelling and the respondents were grouped as residing in thatched hut, pucca houses and RCC houses.

3.5.1.7 Type of family:

Type of family referred to as joint or nuclear and the respondents were grouped accordingly.

3.5.2 Indigenous knowledge on fisheries management:

As already evidenced various researchers based on the context, need and purpose of the study have variously construed the concept of indigenous knowledge. It was therefore, essential to operationalize the concept to suit the context, need for and purpose of the present study. Accordingly, indigenous technical knowledge was operationally defined as the knowledge, which people in a given community and area have acquired through experience, wisdom and experimentation over the generations.

Further it was also evident from the literature review that the research on indigenous knowledge has focussed mainly on documentation, validation and application of the indigenous knowledge in the development process. However keeping in view the objectives of the study, it was decided to limit the focus to only documentation and validation aspects. For this purpose the following aspects of fishery management were identified based

on survey of literature and dialogue with experts and the same were included in the study.

1. Fishing crafts: Efforts were made to document ITK's on various aspects of crafts such as the type of construction material used, dimensions, crew number, fish hold capacity, etc.
2. Maintenance of crafts: This referred to the various indigenous ways and indigenous material used to prevent the wear and tear and also in the regular upkeep of the crafts.
3. Fishing gear: It was operationalized to include type of gear used, fabrication material used, parts of gear and their specifications (in terms of length/ breadth/ height), mesh size, type of floats and sinkers used, depth of operation.
4. Maintenance of gear: This referred to the various indigenous ways and indigenous material used to prevent the wear and tear and also in the regular upkeep of the gears.
5. Fish preservation and processing: This specifically covered the various indigenous methods used by fishers to preserve and process (value addition) the fish.
6. Fish storage: Indigenous methods of storage of fresh and processed fish together with specification and fabrication material used in storage structures were studied in this aspect.
7. Fish packaging: It referred to the indigenous methods of packaging fresh and processed fish.
8. Fish transport and marketing: It referred to the means of transport used for carrying the fish from landing centre to the place of disposal; time lay in catch and marketing; marketing methods used and channels preferred.
9. Fishing time: Time preference of fishers for various fishing methods were documented.
10. Identification of fishing ground: It referred to the indigenous ways used by the fishers to identify the particular fishing ground.

11. Winds and availability of fish: This aspect included various prevailing winds and their effect on fish catch.
12. Tides and their effect: Different types of tides and their effect on fish catch and nets as perceived by the fishers was covered in this aspect.
13. Information on cyclone: Various indicators of cyclone/storm as perceived by the fishers were documented. The perceived significance of fish behavior and other aquatic organisms before or during the cyclone was also noted.
14. Water colour and fish availability: In this aspect the significance of particular water colour in getting particular fish shoal/ catch was documented.
15. Lunar cycle and fish availability: The effect of lunar cycle on nets and availability of fish to various gears was covered in this aspect.

3.6 Assessment of ITK:

Recognizing the general value of IK is important. But at the same time assessing specific ITK for application in development projects is equally significant. To use ITK in development projects we must be selective as some ITK is out of use. Therefore, methods should be established to assess ITK to confirm its validity. Assessing IK means identifying potentially useful ITK and evaluating its effectiveness.

In view of the above and in the light of the objectives of the present investigation, it was felt essential to assess the documented ITK's on fishery management of coastal Maharashtra to establish their rationale and validity. For this purpose based on review of literature and discussion with experts a checklist of seven criteria was identified. The selected criteria and their operational meanings are as follows.

3.6.1 Criteria for assessing ITK:

While assessing each type of IK, the following criteria were considered.

Scientific value/logic: Does it have any scientific background? What is the rationale behind its use?

Efficacy: Does it work? Is it effective? Under which conditions?

Cost-effectiveness: Is it cost effective? Is it affordable to poor people?

Availability of materials: Are materials available in the location? Whether in sufficient amount?

Easy to follow/practice: Is it easy to follow? What are the potential constraints? Whether can they be overcome?

Cultural appropriateness: Is it culturally appropriate to be accepted? (Apply when IK is introduced to another location).

Environmental soundness: How does it affect the environment?

For the purpose of validity assessment of ITK's, a proforma comprising of the above criteria listed against each documented ITK was generated. This proforma was then subjected to thorough scrutiny of scientists/academicians/ development personnel working in area of fisheries management across the country. The experts were requested to critically assess each of the documented ITK's against the identified criteria and indicate their judgment for agreement (with a ✓) and disagreement (with an X) for the same. For a period of two months, 30 experts could positively respond to this exercise and the same proformae were analyzed.

3.7 Tools and methods of data collection:

Data collection was carried out according to the selected research design based on the exploratory survey. The data were collected with the help of a semi-structured interview schedule designed by incorporating all the aspects on which the information was required. To support the findings of the data non-participant observation was carried out and documentary evidence noted. The interview schedule was pretested in non-sample village to overcome the ambiguities and redundancies in the interview schedule. The respondents were contacted individually either at the society, home or at the landing center. Some open-ended questions were asked to access the indigenous knowledge on the aspects that came naturally during the interview. As and when it was deemed necessary the cooperation of the Chairman/Secretary of the concerned fisheries co-operative societies were taken whenever needed. The interview was taken in a healthy and friendly atmosphere.

RESULTS

4. RESULTS

The results are presented under the following heads in line with the objectives of the study.

4.1 Profile of respondents

4.1.1 Distribution of respondents by their age

Age-wise distribution of respondents (Table 3 and Figure 2.i) shows that majority of them (57%) belong to the middle age category followed by 22.00 and 21.00 percent in old and young categories, respectively. Thus, it could be inferred that nearly six out of every ten fishermen of Mumbai and Sindhudurg districts are of middle age.

4.1.2 Distribution of respondents based on marital status.

It is evident from Table 3 and Figure 2.ii that a large majority of them (89.00 %) were married and only 11.00 percent were unmarried.

4.1.3 Distribution of respondents by education

A cursory look at Table 3 and Figure 2.iii reveals that over half of the respondents (52.00 %) had a formal schooling up to primary level, followed by 17.00 percent, 14.00 percent and 4.00 percent who were educated up to high school, were able to read and write and able to read only, respectively. Illiterate fishers constituted 12.00 percent. Thus, it could be inferred that majority of the respondents were literates.

Table 3: Profile characteristics of respondents

(n=100)

Sr. No.	Profile characteristics	Categories	Respondents	
			Frequency	Percentage
1.	Age	Young (up to 30 years)	22	22.00
		Middle aged (31 to 50 years)	57	57.00
		Old (more than 50 years)	21	21.00
2.	Marital status	Unmarried	11	11.00
		Married	89	89.00
3.	Education	Illiterate	12	12.00
		Read only	4	4.00
		Read and write	14	14.00
		Primary school	52	32.00
		High school	17	17.00
		College	1	1.00
4.	Type of family	Nuclear family	83	83.00
		Joint family	17	17.00
5.	Size of family	Small (<4 members)	32	32.00
		Large (>4 members)	68	68.00
6.	Experience in fishing	Up to 10 years	36	36.00
		11 to 20 years	42	42.00
		More than 20 years	22	22.00
7.	Type of house	<i>Pucca</i> house	86	86.00
		Thatched hut	14	14.00

4.1.4 Distribution of respondents based on experience

It is evident from the data presented in table 3 and figure 2.iv that 42.00 percent of the respondents were having experience between 11 to 20 years followed by 36.00 percent and 22.00 percent of them who had experience up to 10 years and more than 20 years, respectively. This suggests that majority of fishers in Mumbai and Sindhudurg districts have fishing experience of more than 10 years.

4.1.5 Distribution of respondents based on type of the family

A cursory look at table 3 and figure 2.v shows that majority of the fishers (83%) were having nuclear family while the remaining 17.00 percent lived in joint family.

4.1.6 Distribution of respondents based on size of the family

Table 3 and figure 2.vi conclusively reveal that a majority of respondents (68%) were having large family (>4 members) while the rest were having small family.

4.1.7 Distribution of respondents based on type of house owned

More than three-quarters (86%) of the respondent fishers were living in *pucca* houses while remaining 14.00 percent dwelled in thatched huts (Table 3 and figure 2.vii).

4.2 Indigenous technical know-how on fishery management

This section deals with the ITKs documented in the two coastal districts studied for the purpose. For the sake of convenience and ease in reading and comprehension, the results are presented as per the various aspects of fishery management studied.

Fig 2 Profile characteristics of respondents

Fig 2i Age of respondents

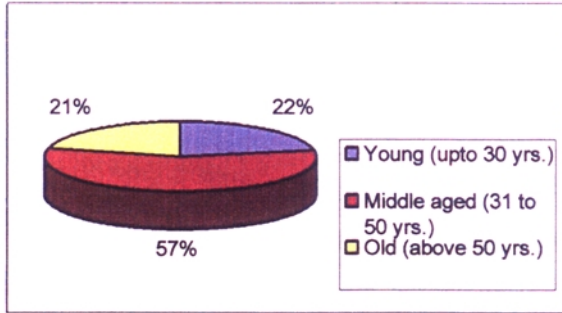


Fig 2ii Marital status of respondents

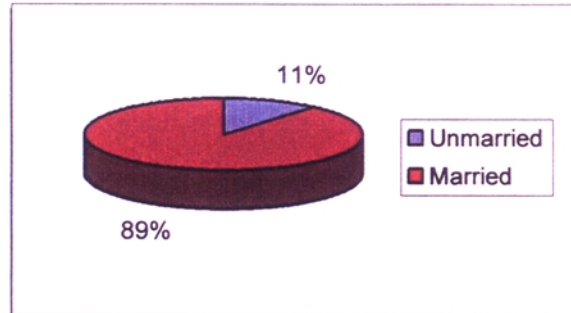


Fig 2iii Education of respondents

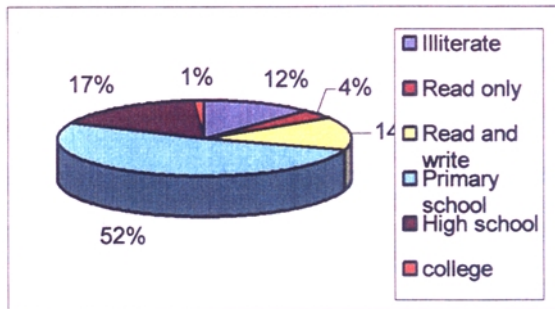


Fig 2 iv Type of family of respondents

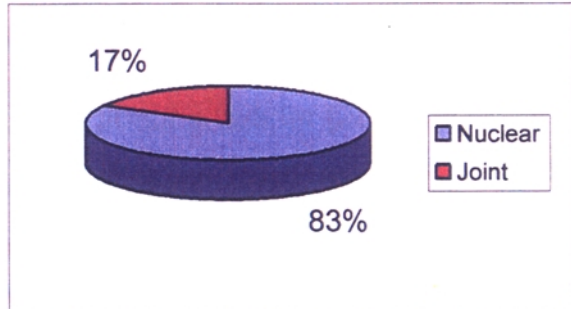


Fig 2 v Size of family of respondents

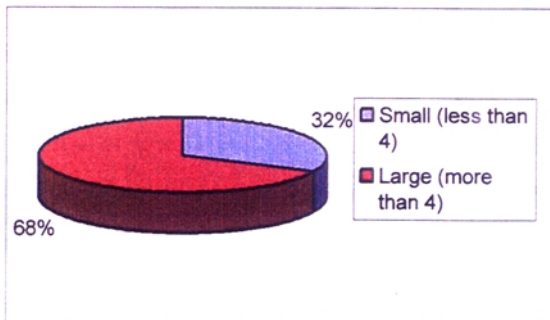


Fig 2 vi Experience of respondents in fishing

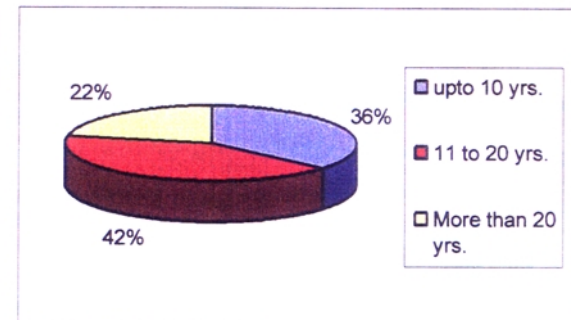
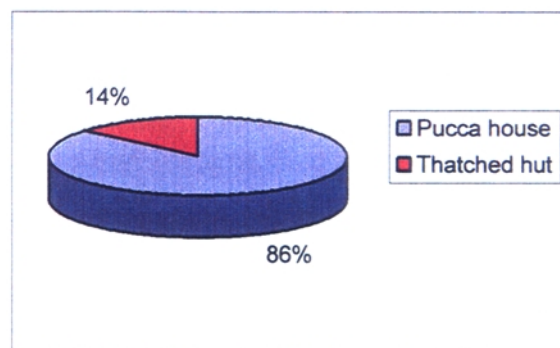


Fig 2 vii Type of house of respondents



4.2.1 ITK on fishing crafts

Keeping in view the diversity of the two districts studied for documenting ITKs, the data pertaining to ITKs on fishing crafts is presented district-wise.

4.2.1.1 Construction material used for boats

The data in table 4 presents the district-wise comparison of the type of construction materials used by the fishers and the parts constructed with reference to fishing crafts.

A cursory glance at table 4 reveals that a large majority of the fishers of Sindhudurg district (70.00%) constructed their crafts using wood from mango tree (*Mangifera indica*) for keel and *undal* (*Calophyllum inophyllum*) tree wood for rest of the parts and about a quarter (26.00%) used mango tree wood for the entire craft. On the other hand majority of the respondents (56.00%), from Greater Mumbai district, used teakwood (*Tectona grandis*) as construction material for the entire craft. Around one-third (34.00%) of the fishers of Greater Mumbai used a combination of teakwood and babul (*Acacia arabica*) tree wood. It was found that teakwood is used for constructing keel and lower hull while babul is used for upper planks and deck beams. About 8.00 percent of fishers practicing long lining in Mumbai used a combination of teakwood and mango wood for their crafts. Teakwood is used for upper hull and mango wood is used for keel and lower hull. It is, however, interesting to note that mango tree wood as a construction material for fishing crafts was preferred by very few fishers of Greater Mumbai district much in contrast to their counterparts in Sindhudurg district. In Sindhudurg district, fishers fitted their crafts having width less than about 4ft. with outrigger to ensure stability during operation. This outrigger is made up of mango tree wood.

Table 4 : District-wise distribution of respondents based on the use of indigenous materials for boat(craft) construction

(n = 100)

Material used and the parts constructed	District-wise distribution of respondents		
	Sindhudurg* (n ₁ = 48)	Greater Mumbai (n ₂ = 50)	Total (n = 98)
Mango tree wood for keel and undal tree wood for rest of the boat	35 (70.00)	--	35 (35.00)
Mango tree wood for the entire boat	13 (26.00)	01 (02.00)	14 (14.00)
Teakwood for the entire boat	--	28 (56.00)	28 (28.00)
Teakwood for keel and lower hull and Babul tree wood for upper planks and deck beam	--	17 (34.00)	17 (17.00)
Teakwood at upper side and mango tree wood for keel and lower hull.	--	04 (08.00)	04 (04.00)

**Responses received from 48 respondents as two fishers owned fibre boats.
(Figures in parentheses are percentages to the respective column totals)*



Figure 3 A *dol* netter of Mumbai coast



Figure 4 A *rampani hoda* of Sindhudurg district

4.2.1.2 Dimensions of fishing crafts

It was observed during the course of study that the two study districts represent two distinct areas in terms of location and type of fishery. Hence an attempt was made to compare the major fishing crafts of the two districts in terms of dimensions like shape, overall length, width, depth, fish hold capacity, etc. Efforts were made to note down the dimensions by participant observation method wherever fishers were unable to provide such information. District-wise information on the various dimensions of major fishing crafts is presented below.

Mumbai district:

Fishers operating bag-net use mechanized crafts of OAL varying from 18 ft to 42 ft with width between 8 ft to 16 ft and depth 3.5 ft to 5.5 ft. These boats are of 'U' or 'V' shaped. They are fitted with 20-64 HP engines. Their fish hold capacity varies between 1-2 tonnes.

Fishers operating gill nets used mechanised fishing crafts with OAL ranging from 15 ft to 40 ft and width 3 ft to 12 ft. They have a depth of 3 ft to 5.5 ft. These boats are fitted with 16-48 HP engines. The fish hold capacity is around 1 to 1.5 tonnes.

Fishers operating traditional trawlers also use mechanized fishing crafts. The OAL varies from 18 ft to 25 ft and width between 3.5 ft to 9 ft. Their depth varies from 2.5 ft to 3.5 ft. These crafts are fitted with 20-36 HP engines. The fish hold capacity is around 1-2 tonnes.

Long line operating fishers also used the mechanised fishing crafts of OAL between 12 ft to 20 ft, width between 2 ft to 6 ft and depth from 2 ft to 4 ft. These crafts are fitted with around 28 HP engines. Fish hold capacity is about 1 tonnes.

Sindhudurg District:

Operation of shore-seine forms an important fishery in this district. The shore-seine is also known as *Rampani*.

Fishers operating rampani use non-motorized fishing craft known as *hoda*. This boat has overall length (OAL) of 20 ft to 30 ft with width between 5 ft to 10 ft and depth of 4 ft to 7 ft. This boat is 'U' or 'V' shaped but mostly they are of latter shape with steep pointed bow.

Fishers operating gill nets use motorized boats fitted with outboard engine (8-15 H.P.). Crafts used for gill-netting are locally known as *hodi*. Its OAL ranges between 15 ft to 27 ft, width between 3 ft to 6 ft and depth between 2.5 ft to 3.5 ft. These crafts are fitted with outboard motors of 8-15 BHP. Their fish hold capacity ranges from 0.5-1.0 ton.

Small gill-netters are known as *pagar*. They are dugout canoes operated nearby coast. The crafts used for long-line are mechanized, have OAL around 22 ft to 25 ft with width between 2.5 ft to 4 ft. Their depth varies from 1.75 ft to 3 ft. They are fitted with 25-32 HP engines. Their fish hold capacity is about 2 tons.

Small number of fishers operating long lines use fishing crafts motorized with about 8HP engines. Other long liner boats, which fish in about 60 fathoms depth, are mechanized with 32HP engines. Their OAL ranges between 20 ft. to 30 ft., width between 2.5 ft to 8 ft and height between 2 ft to 6 ft.

4.2.1.3 Information about crew number

The strength of crew mainly depends on type of fishing, dimension of gears and the extent of motorization / mechanization. Dol net operation in Mumbai required crew strength about 4-8 members. Gill net operation either in Mumbai or Sindhudurg district require a crew of 1to 6 members. Long line operation in both the districts required a crew of 2 to 6

members. The operation of traditional trawl requires about 4-6 members. *Rampani* boats are operated by more number of members (about 30-40) to carry out the entire operation, but about 6 - 15 members are required to carry and pay the net.

4.2.2 Maintenance of crafts

Depending on the size of crafts, fishing crafts are invariably given treatment of *chandrus* a type of resin (origin unknown to fishers) and oil such as groundnut oil, linseed oil in Mumbai district and *chandrus* with *undal* tree oil or cashew oil in Sindhudurg district. The above ingredients are mixed in 1:3 to 1:5 ratio (*chandrus*:oil) and boiled for 3-8 hours. It is applied warm with cloth or brush to exterior and interior surfaces of boat in Sindhudurg district while it is sprinkled hot on boats surface using an earthen dish in Mumbai district. This treatment is done 2-3 times a year to give the boat strength and durability. Fishers of Sindhudurg district also use a paste of *undal* oil, *chandrus* and lime in equal proportion to fix the leakages. This treatment takes about two hours of drying.

4.2.3 ITKs on fishing gears

Specific fisheries in terms of fish species availability, fishing crafts and gears used, characterize the two districts considered for the study. Therefore, a comparative analysis of the ITK's on fishing gears was attempted for the two districts studied. Data presented in table 5 gives a comparative account of the types of fishing gears used by the fishers of the Sindhudurg and Greater Mumbai districts.

It could be observed from table 5 that majority of the fishers of Sindhudurg district (54%) use gill nets followed by 40.00 percent fishers operating shore-seines. A meager 6.00 percent of respondents from Sindhudug district operate long lines. On the contrary, bag net is the major fishing gear in Greater Mumbai district as the maximum percentage of respondents from this district (44.00 %) operate bag net. Gill net (32%) was



Figure 5 Iron barrel used for preparing the chandrus + oil solution; a small vessel with handle to take it out and earthen dish used to apply the solution to the crafts in Mumbai district



Figure 6 A copper vessel used for preparing the chandrus + oil solution in Sindhurg district

the second most commonly operated fishing gear in greater Mumbai district as well. Long lines (14%) and traditional trawl (10%) were the other gears operated by the fishers of Greater Mumbai district.

Though some of the respondents owned more than one net, they were shown against the gear, which they used quite often.

Overall for the entire study area, gill net emerged as the major fishing gear as 43.00 percent of the respondents operated it followed by bag net (22%), shore-seine (20%), long line (10.00) and hand trawl (5%) in that order.

As there was considerable variation in the type of fishing gear used by fishers in the two study districts it was felt convenient to present a district wise description of the fishing gears in terms of gear dimensions, mesh-size (Table 6), depth of operation (Table 7) and time of operation (Table 8).

Mumbai District:

4.2.3.1 Dol Net

The dol or set bag net fishery is one of the major fisheries of Maharashtra state. It is commonly used along the Mumbai coast. Forty-four percent respondents covered under the present study resorted to dol net fishing. The catch of dol net mainly comprises of fishes like Bombay duck, penaeid and non-penaeid prawns, ribbon-fishes, pomfrets, anchovies, etc. The net is basically a large conical bag with mouth portion rectangular in shape and end portion tapering. The length of the net varied from 150 ft to 210 ft, width between 80 ft and 120 ft and height between 30 ft to 35 ft. The net has mesh size of about 280 mm at mouth to 5 mm at end. It is operated at 5-20 fathoms depth. The fathoms are referred to as *Vav* in fisher's language of this region. Dol net is made up of five parts having different length and mesh sizes. The number of meshes and mesh size increases

from cod end to mouth. Five parts of dol-net are locally known as *Mor*, *Cherati*, *Katra*, *Mazola* and '*Khola*' from mouth to cod end.

Depending on the mooring material used, dol net is operated by five different methods namely, *bokshi* (thin bamboo or wooden poles), stone-heap, stake, spike or *khunt*, and anchor.

Of these, the spike or khunt type is more popular method. Since the size and operational methods of dol net largely depend on the location specific requirements besides target species, they show certain variations from place to place. Most of the respondent fishers followed spike dol net operation with few resorting to anchor dol net.

4.2.3.1.1 Spike or khunt type dol net

Generally a group of 2-3 nets are set broadly in parallel rows at different depth levels between 5-20 fathoms. At the beginning of fishing season (September), most of the boats operate their nets in shallow water. As the season progresses they move to deeper waters where they continue to fish till late May or early June. The mouth of the net faces the current to filter the water and retain the fish. It is reversed when the tide recedes.

(i) Setting of spike and its function

The spike is driven into floor of sea by using a lengthy stake to which spike is attached by iron bracket. The stake is made up of pieces of teak joined together by lap joints. It is also called as spike driver or locally as *Musal*. The spikes are tied with two ropes and inserted laterally across each spike to prevent loss of spike at the lowering of stake. The complete operation is done with two boats.

Table 5 : District-wise distribution of respondents based on the type of fishing gears operated by fishers

(n = 100)

Type of fishing gear (net)	District-wise distribution of respondents		
	Sindhudurg* (n ₁ = 50)	Greater Mumbai (n ₂ = 50)	Total (n = 100)
Gill-net	27 (54.00)	16 (32.00)	43 (43.00)
Bag-net	--	22 (44.00)	22 (22.00)
Shore-seine (<i>Rampani</i>)	20 (40.00)	--	20 (20.00)
Long line	03 (06.00)	07 (14.00)	10 (10.00)
Traditional trawl	--	05 (10.00)	05 (05.00)

(Figures in parentheses are percentages to the respective column totals)

Table 6 : Mesh size of major fishing gears

Type of net	Mesh size	Frequency*	Percentage
<i>Disco</i> gill nets	25 mm – 45mm (20 mm – 40.5 mm) Inner (outer)	09	09.00
Mackerel gill net (<i>Tiyani</i>)	65 mm	07	07.00
	50 mm	06	06.00
Pomfret gill net	50 mm	02	02.00
Seerfish gill net (<i>Iswan</i>)	180 mm	03	03.00
Surface gill net	150 mm	03	03.00
	120 mm	02	02.00
	250 mm	01	01.00
Bottom gill net	120 mm	02	02.00
<i>Shahenshah</i> gill nets	50 mm (150 mm) Inner (outer)	02	02.00
Gill nets	Others	06	06.00
Dol net	230 mm -5 mm	07	07.00
	150 mm -5 mm	07	07.00
	350 mm -8 mm	03	03.00
	300 mm -5 mm	03	03.00
	220 mm -8 mm (Mouth to end)	02	02.00
Rampani	10 mm - 50 mm	11	11.00
	5 mm – 50mm	05	05.00
	5 mm - 25 mm (Center to side)	04	04.00
Traditional trawl	5 mm – 25 mm	03	03.00
	18 mm – 25 mm (Mouth to end)	02	02.00

*** Ten-percent respondents resorted to long lining.**

Table 7 : Depths of operation of major fishing gears nets

Type of net	Depth of operation	Frequency	Percentage
Disco gill nets	10-15 vav*	07	07.00
	8 vav	02	2.00
Tiyani gill nets	7-10 vav	12	12.00
	20 vav	03	03.00
Pomfret gill net	20 vav	02	02.00
	35 vav	01	01.00
Iswan gill nets	25-30 vav	03	03.00
Surface gill net	15-22 vav	04	04.00
	25 vav	01	01.00
Bottom gill net	3-20 vav	02	02.00
Shahenshah gill nets	5 vav	02	02.00
Dol net	5-10 vav	06	06.00
	10-20 vav	05	05.00
	5-7 vav	03	03.00
	7-15 vav	03	03.00
	10-12 vav	02	02.00
	6-12 vav	01	01.00
	4-8 vav	01	01.00
	1-4 vav	01	01.00
Long line	6-15 vav	07	07.00
	30-60 vav	03	03.00
Rampani	4-5 vav	18	18.00
	6-8 vav	02	02.00
Traditional trawl	7-12 vav	05	05.00
NR	-	04	04.00

*** Fathom is referred to as vav in fisher language**

NR-Not responded

Table 8 : Preference time for fishing for the major gears

Type of net	Preference time	Frequency	Percentage
Disco gill nets	4 am - 8 am	06	06.00
	5 am - 8 am	02	02.00
	5 am - 9 am	01	01.00
Tiyani gill nets	4 am - 7 am	06	06.00
	6 am - 9 am	03	03.00
Pomfret-gill net	4 pm - 8 am	02	02.00
	6 pm - 10 pm	01	01.00
Iswan gill nets	6 pm - 2 am	01	01.00
	6 pm - 4 am	01	01.00
Surface gill net	6 pm - 6 am	02	02.00
	5 am - 11 am	02	02.00
	6 pm - 4 am	01	01.00
	5 pm - 12 pm	02	02.00
Bottom gill net	5.30 am - 8.30 am	02	02.00
	5 am - 5 am	01	01.00
Shahenshah gill nets	5 am – 8 am	02	02.00
Dol net	Based on tidal energy (2 times a day against high tide)	07	07.00
	4 times a day (2 for high tide and 2 for low tide)	08	08.00
	2 times a day (against low tide)	07	07.00
Long line	4 am - 7 pm	03	03.00
	6 am - 11.30 am	02	02.00
	5 am - 12 pm	02	02.00
	4 am - 5 pm	02	02.00
	5 am - 3 pm	01	01.00
Rampani	4 am - 8 am and 6 pm - 9 pm	09	09.00
	4 am - 7 am and 6 pm - 9 pm	05	05.00
	3 am - 6 am	03	03.00
	6 am - 8 am	03	03.00
Traditional trawl	3 am - 9 am	03	03.00
	2.30 pm - 4.30 am	01	01.00
	5 am - 5 pm	01	01.00
NR	-	08	08.00

NR-Not responded

After arriving to fishing ground, four anchors are driven in forward and backward direction to fix the position of the boats. The two boats are then brought side-by-side so that they are linked together by using the most of each boat by rope and pulley. The stake is raised and lowered into water when it is upright. The rope from the upper part of the stake is drawn under the cross log and then taken into vessels. The pile is driven into the bottom by the force and upward and downward movements of water. When the boat raises the rope from the uppermost pile is held tightly. When the boat goes downwards into water trough, the piles are driven in to the bottom. In this manner, powerful wave energy generated by alternate surging and receding action results in reported vigorous pounding down of the spike, which starts deeper and deeper into the bottom. The process is continued till the spike is driven 5-6 m deep into the muddy sea bottom.

(ii) Ropes used in dol net operation

The dol net is operated with the help of a frame of ropes rigged to spikes, which act like fixed stations in the sea.

'Farya' and *'Heti'* - They are actually ends of two ropes tied around spike in form of four corners of bridle. The twin *'faryas'* and *'hetis'* are tied to upper and lower corners of the net.

'Khalya' - Two ropes of length 150 feet each are used to pull head and foot rope together during the operation.

'So' - Two ropes of 150-200 ft length are used to adjust the operational depth of the net. Its one end is attached to floats and the other end to the rope of the station.

'Chalani' - One rope of 250 to 350 ft is used for tying the boat to the station.

'Toran' - These are 4 ropes of varying thickness (12-20 mm), which are used for fastening the net at four corners of the bridle. Slipknots are used to make it free from the bridle while hauling.

'Era' - The cod-end of net is closed by one end of a rope called era while its other end is tied to the middle of head rope.

'Balan' - The successive bridles are connected with *balan* which is 150 to 200 feet long rope at the middle of *khalya* of either bridle and help the boat from going from one bridle to another.

(iii) Operation of the net

The actual operation involves fixing of net to the bridle so that it faces the tide, at its onset and hauling it before the change of tide. There is a difference of approximately 50 minutes each day as far as fixing of the dol net is concerned. Suppose today the net is fixed at 6a.m. at the start of high tide, next day the same net is fixed at 6.50a.m. The four rings present at four corners of the net and called *chaura* facilitate easy fastening of net to bridle by means of slipknots.

(a) Paying operation:

After reaching the fishing ground, the bridle is located by means of marked floats. Then the So rope attached to the last float is pulled by crew until the centre of *khalya* where *balan* is also tied is reached. The crew now gets divided into two groups and start pulling *khalya* on either sides to get hold of *farya* and *heti*. The net is then paid by releasing distal portion by closing the cod-end with a rolling hitch of era. Mouth of the net is twisted around a gunwale bollard and *chauras* are tied with help of *toran* to the thimbles of *farya* and *heti*, with slipknots. The other end of *'era'* is tied to middle of head rope and then the remaining net is released into the sea. The net drifts for some time and then its mouth opens due to tidal current. The operational depth of the net is adjusted by manipulating the so length. The boat then moves to second bridle with the help of *balan*, which is tied to

successive bridles, and the entire process is repeated for setting of second net.

(b) Hauling Operation:

After 3 to 3.5 hours of immersion or 1-1.5 hours before the turn of the tide, the hauling operation is initiated by pulling *chalani* to obtain *khalya* to which a pair of *toran* is fastened. When distal ends of 'toran' are pulled with a firm jerk, the bridle holding the net is released. The head and foot ropes of net are collected by crewmembers who pull the lower pair of toran with a jerk, so that the net gets released from the bridle. Then, all the four corners of the net are pulled abroad and the crew starts drawing the net on the boat. The boat then moves to the second net with the help of 'balan' and hauls it in a similar manner.

4.2.3.1.2 Anchor dol net

Anchor dol nets are used in locations where the water current during the tides is comparatively less and there is no need of fixing the dol nets to the spikes. Instead of spikes, anchor weighing about 80 kilos is used as mooring material. A rope about 50 mm wide and 150 ft long is attached to the anchor. Four ropes of same length are tied to this rope, which are in turn joined to a frame. This frame is made up of two strong bamboo poles at upward and downward sides and two ropes at sides. One buoy is attached to the frame with help of another rope.

During start of tide, with the help of buoy the frame is lifted up and the mouth side portion of the net is attached to it. One rope runs upwards from one side to another. At its ends two floats are attached with help of rope. This rope also adjusts the operational depth of the net.

4.2.3.2 Gill nets

It is the net, which stands in upright position in water by floats at the top and sinkers at the bottom. Size of the gill nets depend upon target

species and during operation many pieces are joined together to form a long wall of net, Monofilament or multifilament twine is used for fabrication of the net. The foot rope of most of the gill nets is of same material as that of head rope but the thickness is more.

4.2.3.2.1 Trammel nets

Trammel nets are locally known as *shahenshah* nets. They are essentially three layered nets meant for catching prawns. These nets prevent the escape of prawns by forming a type of purse. The mesh size for inner net is about 50 mm and for outer net it is around 150mm. It is operated at about 5 fathoms depth. The net is operated during 5 am - 8 am. The season is from August to September and May.

4.2.3.2.2 Surface gill nets

Surface gill nets are used for catching pelagic fishes such as pomfrets (*Pampus argentus*), seerfish (*Scomberomorus* sp.). They are operated at 15-35 fathoms depth. The mesh-size varies from 120 mm for pomfret to about 150-200 mm for seerfish. Surface gill nets are mostly operated during 6 p.m. - 6 a.m.

4.2.3.2.3 Bottom gill nets

Bottom gill nets are used for catching sharks (*Scoliodon* sp.), catfishes (*Tachysurus* sp., *Aries* sp.). Lobsters (*Panulirus* sp.), crabs (*Scylla serrata*), etc. Their mesh-size varies from 75 mm to 200 mm. They are operated at 3-20 fathoms depth, during 5.30 a.m. to 8.30 a.m.

4.2.3.3 Traditional trawl

The difference between traditional trawl and modern trawl is that unlike modern trawl, which are hauled on board with the help of winches connected to engine, the traditional trawls are hauled manually. The length of traditional trawl varies from 25 ft to 100 ft with width between 12 ft to 40 ft and height from 8 ft to 12 ft. It is operated at 7-12 fathoms depth. The mesh

size varies from 25 mm at mouth to 10 mm at end. The catch comprises mainly of prawns, squids, ribbonfish, anchovies, etc. The nets are operated during 3 a.m. - 9 a.m. popularly. 10.00 percent respondent fishers practiced traditional trawling.

4.2.3.4 Long Lines

The long line ropes are divided into 10-30 parts with length of each part varying from 360 ft to 720 ft. with 60-120 hooks suspended per part. Different hook numbers are used such as hook no. 3, hook no.7, hook no.9, etc. with respect to the target species sought. Plastic cans are used as floats while stones are used as sinkers. They are essentially set long lines. The catch of long line mainly comprises catfish, such as *Arius* sp., sharks of *Scoliodon* sp., eels, spotted grouper (*Epinephalus maculatus*), Indian salmon (*Eleutherima tetradactylum*), etc.

Long line ropes are fabricated of cotton. They are operated at a depth of 6-25 fathoms. They are mostly operated during 4 a.m. - 7 a.m. followed by 6 a.m. - 11.30 a.m.

Sindhudurg District:

4.2.3.5 Rampani

Shore-seine commonly known as *Rampani* is operated along Malabar, Konkan and Karnataka coast. In Konkan coast it is concentrated in Sindhudurg district where it constitutes an important traditional fisheries.

Rampani is around 900 to 8,000 ft long. As it is very long, it is prepared by joining together pieces of nets. At both the ends of the net, the height of the net is less and mesh size large. Towards the centre the height of the net increases and its mesh size decreases. Generally the net is operated nearby shore at 4-5 fathoms depth.

Rampani is divided into three parts namely, *Karal*, *Modan* with about 8 pieces and *Ghol* with around 8 pieces.

Karal and *Modan* form the two terminal sides while *Ghol* forms the central portion of the net.

Rampani is commonly operated during 4 a.m. - 8 a.m. and 6 p.m. - 9 p.m. Large *rampani* nets are operated with 30-40 fishers while the smaller ones are operated with the help of 10-15 fishers. The catch of *rampani* mainly comprises of shoaling fishes such as mackerel, sardines, ribbon-fishes, squids, etc.

4.2.3.5.1 Formation of Rampani group (*Sangh*)

Generally, 30-40 fishermen collectively own a *Rampani* net. The members are included as per their contribution in the form of piece of net or monetary input. These fishers become permanent members. Some temporary members may be included on daily payment basis. These groups are called '*Rampani Sangh*'. Head, locally called *Mukadam*, looks upon the functioning of *rampani sangh*. He is responsible for storing the net, its assets, inclusion of temporary members, decision about operation of net, etc. He also make teams among the sangh those who will go for paying the net on rotation basis, comprising 8-10 fishers such that each team gets its turn after a gap of 3-4 days. Another person, a treasurer called *hundiwala*, looks upon the money matter. He is responsible for paying wages to temporary members, keeping the record of earning and turnover, showing account to members and distributing earnings to them. The whole proceedings of *sangh* take place in a shed constructed near shore.

Way of working

Rampani is a seasonal fishing activity extending from August to January lasting for about six months.

Actual working

The net is operated nearby shore in about 4 fathoms depth. During operation, a person called as *telani* is sent out in small boat *hodi* to

look out for and signal the arrival of fish shoals. He locates the shoal based on the colour of the water.

Indian mackerel, *Rastrilliger kanagurta* shoal is identified as blackish oval-shaped shoal which swims with upturned mouth above the surface of water. Oil sardine, *Sardinella longiceps* shoal is identified as fast swimming one with front side of shoal thrusting forward and coming above the water surface.' Sardine, *Sardinella fimbriata* shoal is identified by splashing sound produced by fish owing to splashing of their tail on water.

Immediately the *telani* makes a signalling shout, upon hearing which net laden craft called *hoda* is sent to pay the net in semi-circular way encircling the shoal. One end of the net is handed over to men on the shore and other end of the rope is brought to another point on shore. Both the groups of men then drag the net.

4.2.3.5.2 Rotation of *rampani sangh*:

A unique characteristic feature of this fishery is the rotation system of *rampani sangh*. If there are several *rampani sanghs* operating on the same stretch of shore and during the same season, each one of them gets a chance to fish by turn. This turning out or rotation system is based on mutual understanding and is strict binding on all *rampani sanghs*. The *sanghs* wait for their turn by keeping the net laden craft anchored nearby shore adjacent to first *sangh*. When their turn comes fishers again go out in dinghy to the craft, bring it back, hand one end of the rope to people on shore and pay the net. This rotation of *sangh* is carried during peak season when fish shoals are abundant nearby coast.

4.2.3.5.3 Sharing of profit from catch

The catch after landing is sorted. Some portion of catch is set aside for self-consumption and rest is auctioned at the beach. If large quantity of catch is obtained at late evening or night, the net is not entirely hauled but up to very near to coast such that the fishes caught remain still in

the water and both ends of the rope are brought together and tied to boat or any fixed object. The net is then hauled in morning and the catch is auctioned. After receiving money from auction, a fix amount is kept aside as working capital and maintenance cost. Rest is distributed equally among fishers except the head of the sangh who gets half of the amount more than that distributed to individual fishers.

4.2.3.6 Gill nets

Gill net fishing forms an important traditional fishery in Sindhudurg along with *Rampani*. The gill nets are specific each with different mesh-size for different species.

4.2.3.6.1 Mackerel gill nets

Gill nets for mackerel are called *Tiyani*. They are made up of nerlon (a type of nylon). Mesh size of the net is about 25 mm. *Tiyani* is operated generally in 10-15 fathoms depth. The fishing season for this net is October to January. The *Tiyani* is commonly operated between 4 am - 7 am followed by 6 am - 9 am.

4.2.3.6.2 Seer fish gill nets

Gill nets used for catching seerfish are locally known as *Iswan*. They are made up of garfield (a type of nylon). Its mesh size is about 180 mm. *Iswan* is usually operated beyond 20-25 fathoms depth. Fishing season is from October to January.

4.2.3.6.3 Trammel nets

Gill nets meant for catching prawns are three layered (trammel net) and known locally as *disco* nets in Sindhudurg. Mesh size for inner net is 25 to 45 mm and for outer nets it is 200 to 400 mm. As described elsewhere these nets prevent the escape of prawns by forming a kind of purse. These are operated nearby shore in 8-12 fathom depth. These are also made up of nerlon and commonly operated from March to June.

4.2.3.6.4 Pomfret gill nets

Gill nets used for catching pomfrets have mesh size of 50 mm. They are operated generally at 20 fathoms depth. The fishing season is from August to November. They are generally operated during 4 pm - 8 am.

4.2.3.7 Long Lines

The long lines are operated in 30-50 fathoms depth. About 150-200 hooks are suspended per part and around 10 such parts are employed per long line. They are generally operated between 4 am to 5 pm. Long line fishing is locally known as *Waval*.

The long line catch mainly comprises of sharks and catfishes. Some fishers pay the line in such a way that half of the hooks lie on muddy bottom and the other half on the rocky bottom. The demarcation, the fishers believe, is at about 30 fathoms depth.

4.2.4 Maintenance of gears

About 8.00 percent fishers practicing long line fishing in Mumbai district carried out the treatment of colouration or tanning to minimize the wear and tear of the cotton ropes.

- (a) Long line ropes made up of cotton are subjected to coloration. This treatment is done to increase the durability of the ropes. The bark of *ain tree (Pterocarpus hirsuta)* is used for this purpose. The bark is cut in to pieces and put in water to obtain a solution. The solution is kept for 2 to 3 days till it becomes dark brown. It is then filtered and the ropes are immersed in to this solution. After proper overnight immersing, ropes are removed and dried.
- (b) To keep the nylon based nets in proper condition; periodic repairs are done as and when needed. After use, nets are washed with water either fresh or sea water and stored in shed. Irreparable parts are replaced by new webbing.

4.2.5 Use of indigenous material for fabrication, floats and sinkers

The data on indigenous materials used for fabrication of gears, as well as for floats and sinkers are presented in this section.

4.2.5.1 Indigenous materials for net fabrication

As far as the type of material used for fabrication of gears, the distribution of respondents was highly skewed with 93.00 percent using nylon-based material. Indigenous material in the form of cotton found use by a very small fraction (7.00%) of them (Table 9).

4.2.5.2 Indigenous materials as floats

It is clear from table 10 that indigenous material for floats in the form of plastic cans / drums were used by 17.00 percent fishers. 'Pangara' wood (*Eryhina indica*) plates were used as floats by 7.0 percent fishers while wooden buoys were used for the same purpose only by 2% of fishers. (Table 10).

4.2.5.3 Indigenous materials as sinkers

Indigenous materials used as sinkers for the nets were in the form of cement rings, stones, iron chains, iron rings, bricks and tiles. Table 11 shows that stones were commonly used (35%), followed by iron chain (17%), cement rings (10%), iron rings (3%) bricks (2%) and tiles (1%).

4.2.6 Fish storage and preservation

4.2.6.1 Fish storage:

A perusal of Table 12 indicates that most of the fishers (90%) stored their catches in bamboo cane baskets after landing followed by 6.00 percent and 4.00 who used wooden box insulated with thermocol and *boskul*, respectively.



Figure 7 Long line ropes being dried after colouration



Figure 8 *Pangara* tree wood plate for *rampani* in Sindhudurg district



Figure 9 Boskul used for storing crabs and lobsters



Figure 10 Bamboo cane baskets used for fish storing fish in Sindhudurg district

Table 9 : Distribution of respondents based on the fabrication materials used for net

Material used	Respondents	
	Frequency	Percentage
Cotton	07	07.00
Nylon based	93	93.00

Table 10 : Type of floats used for nets

Type of float	Frequency	Percentage
Conventional floats	74	74.00
Plastic cans or drums	17	17.00
<i>Pangara</i> wood plates	07	07.00
Wooden buoys	02	02.00

Table 11 : Type of sinkers used for nets

Type of sinkers	Frequency	Percentage
Stone	35	35.00
Iron chain	17	17.00
Cement rings	10	10.00
Iron ring	03	03.00
Bricks	02	02.00
Tiles	01	01.00
Others	32	32.00

Table 12 : Indigenous structures used for fish storage

Fish storage	Frequency	Percentage
Bamboo cane basket	90	90.00
Wooden box insulated with thermocol	06	06.00
<i>Boskul</i>	04	04.00

Table 13 : Indigenous methods fish preservation

Fish preservation method adopted	Frequency	Percentage
Sundrying	23	23.00
Salting followed by sundrying	18	18.00
NA	59	59.00

NA- Fishers not resorting to any fish preservation

4.2.6.2 Fish preservation:

It is clear from the data presented in Table 13 that sun drying was the common method of fish preservation followed by 23.00 percent fishers. Eighteen percent respondents also practiced salting followed by sun drying for the same purpose.

4.2.6.3 Preparation of by-products

Few fishers in Sindhudurg operating long line meant for shark fishing prepared shark liver oil. Shark liver is stored mostly in covered container mixed with some salt. The liver is thus stored for about four to five days. Afterwards the liver is cut into pieces and heated in an iron vessel on wood fire. The oil thus leached out after heating, is collected and sieved.

4.2.7 ITKs on effect of wind directions on availability of fish

The data on ITKs pertaining to effect of wind directions on fish availability as perceived by fishers is presented in Table 14. Overwhelming majority of respondents (97%) opined that winds blowing from northerly direction fetch more fish catch while those blowing from southerly direction fetch very less catch.

About 30% fishers believed that moderate fish is expected when the winds are blowing from west direction. Very negligible percentage of fishers (2%) opined that more fish catch is obtained when wind blows from east direction.

4.2.8 Water colour and availability of fish

It is clear from Table 15 that 82.00 percent fishers believed that muddy water results in more fish catch while 75.00 percent who opined that less catch is obtained in clear (glossy) waters. About 13.00 percent fishers indicated possibility of moderate fish catch in bluish water.



Figure 11 Drying of Bombay Ducks on bamboo platform in Mumbai district



Figure 12 Sundrying of fish after salting in Sindhudurg district

Ten percent fishers believed that more fish are available in greenish water. Very few fishers (4%) opined about availability of moderate catch in clear water and more catch in bluish waters.

4.2.9 ITKs on effect of tides on fish catch and nets

The data corresponding to ITKs documented on the effect of tides on fish catch is presented in Table 16. All the respondents expressed that low tide yields more catch to *rampani* and high tide requires more fishing effort to haul the traditional trawl. Almost equal percentage of respondents believed that high tide yields more catch to dol net (69%) and less fish catch to long line (70%). Nearly two-thirds (65%) opined that transition time between two tides yields more catch to gill-net. Three out of every ten (31%) respondents believe that low tide yields more catch to dol-net. A quarter (25%) of the respondents felt that low tide yields more catch to gill net. Very few respondents (9%) believed that high tide yields more catch to gill net.

4.2.10 ITKs on effect of lunar cycle on fish availability

Table 17 shows that 100.00 percent fishers opined that 12th day to 3rd day and 4th day to 11th day of lunar cycle bring more catches to dol-net and long line, respectively. The periods between 4th day to 8th day and 9th day to 11th day of lunar cycle fetch very less and moderate catch to dol-nets, respectively as opined by all the fishers. As high as 84.00 percent fishers experienced less catch to gill nets during New Moon Day and Full Moon Day.

Table 14: ITKs on effect of wind direction on availability of fish

Wind	Fish availability				
	Nil	Very less	Less	Moderate	More
East	-	-	-	03 (3.00%)	02 (2.00%)
West	-	-	-	30 (30.00%)	-
North	-	-	03 (3.00%)	-	97 (97.00%)
South	-	97 (97%)	-	-	03 (3.00%)

Table 15 : ITK on effect of water colours on availability of fish

Water colour	Availability			
	Nil	Low catch	Moderate catch	More catch
Brown	-	-	03 (3.00%)	-
Green	-	-	-	10 (10.00%)
Bluish	-	-	13 (13.00%)	04 (4.00%)
Muddy	-	02 (2.00%)	-	82 (82.00%)
Clear	-	75 (75.00%)	04 (4.00%)	-

Table 16 : ITKs on effect of tides on fish catch and nets

Type of tide and effect	Percentage of respondents
High tide yields more catch to dol net	69.00
High tide yields more catch to gill net	09.00
High tide yields less catch to long line	70.00
Low tide yields more catch to rampani, facilitates its hauling and provides more space for operation	100.00
Low tide yields more catch to gill net	25.00
Low tide yields more catch to dol net.	31.00
Transition period yields more catch to gill net	65.00
During high tide more effort is required to haul the traditional trawl	100.00

Table 17: ITKs on effect of lunar cycle on fish catch

Type of net	Day of lunar cycle	Effect	Response
Dol net	12 th day to 3 rd day	More catch	100.00
Dol net	4 th day to 8 th day	Very less catch	100.00
Dol net	9 th day to 11 th day	Moderate catch	100.00
Long line	4 th day to 11 th day	More catch	100.00
Gill net	New Moon Day and Full Moon Day	Less catch	84.00

4.2.11 ITKs on indicators of cyclone / storm

Fishers have their own logic and ways of predicting the occurrence of cyclones and storms. An attempt was therefore made to elicit ITKs to this extent and the information so gathered is presented in Table 18. A perusal of table 18 reveals the diversity of ITKs as indicators of cyclone / storm. Majority of the respondents expressed (62%) gave a positive nod to 'increase in intensity of water currents' as indicator of occurrence of storm within few hours. 'Wind gushing from southern direction' was a sign of occurrence of cyclone as per 44.00 percent respondents. Other indicators such as 'sea-water remains exceptionally calm', 'accumulation of black clouds at horizon', 'increase in turbidity of nearshore water', 'mud entry in net in the form of flat nodules', 'features such as rocks, lighthouse look clear and very near', 'uneasy feeling due to excessive sultriness' and 'sun encircled by a kind of ring' were expressed by 21.00, 18.00, 18.00, 15.00, 12.00, 8.00 and 5.00 percent respectively as an indication of occurrence of storm.

4.2.12 ITKs on behaviour of fish or other aquatic organisms before, during or after cyclone

By virtue of their co-living with the fish and other aquatic organisms, fishermen are expected to have developed some notions on specific abnormal behaviour of fish and other aquatic organisms before, during or after cyclone. Realizing this information was gathered on these lines and presented in table 19. The general response of fishers to this query was not up to the mark as evidenced from poor responses in Table 19. Curling together and coming to the surface of *Mharuche* a type of sea-snake (6.00 %), transverse (tilting) swimming behaviour of black pomfret, *Apolectus niger* (6.00 %) and sudden disappearance of fish (4.00 %) were a few such ITKs documented albeit with poor response. Other indications of occurrence of cyclone or storm included flocking of small seabirds unusually nearby shore, less or more fish catch than expected and croaking sound from *ghol* (*Protonebia dicanthus*).

4.2.13 Observance of closed season

Majority of the respondents (84%) reported that they observe closed season (Table 20).

4.3 Assessment of documented ITKs

As mentioned elsewhere, the major ITKs documented in the study on various aspects of fisheries management were subjected to their validity assessment by a group of 50 fisheries experts out of which 30 experts positively responded. The data thus generated is presented in this section under relevant sub-heads. Only those ITKs were subjected to assessment for validation, which were popularly applied or followed.

4.3.1 Assessment of ITKs on fishing crafts

For the purpose of validity assessment of ITKs on fishing crafts, the major documented ITKs on construction material used alone was considered and the results to this extent are presented in table 21.

A thorough examination of table 21 conclusively establishes the superiority of teak wood as a boat construction material as more than three quarters (76.66%) of the experts indicated that teak wood as efficient material and use of teakwood for the entire boat has scientific value / logic. Use of teakwood in combination with babul tree wood was also rated high on scientific value (66.66%) and efficacy (76.66%) by majority of the respondents. A comparison of the four categories of boat construction materials documented in the study reveals that use of mango tree wood alone and mango tree wood in combination with *undal* tree wood were rated high on the criteria such as local availability of material, cost effectiveness and ease of construction. However, majority of the experts opined that the above ITKs involving mango tree wood and undal tree wood are relatively poor in terms of scientific value, efficacy, cultural appropriateness and environmental soundness.

Table 18 : ITKs on indicators of cyclone

Indicator and Consequences	Frequency	Percentage
Sun encircled by kind of ring indicates occurrence of cyclone within few days.	05	05.00
Nearshore water slowly starts getting turbid.	18	18.00
Intensity of current increases indicating occurrence of storm within few hours.	62	62.00
Wind gusting from south direction.	44	44.00
Sea-water remains exceptionally calm.	21	21.00
Black clouds are seen at horizon.	18	18.00
Mud gets into net in form of flat nodules.	15	15.00
Nearly features look very clear and distant.	12	12.00
People feel uneasy due to sultriness.	08	08.00

**Table 19 : ITKs on behaviour of fish and other organisms
before, during or after cyclone**

Behaviour of fish and other organism	Frequency	Percentage
<i>Mharuche</i> - a type of sea snake, curl together and come to the surface	06	06.00
Small birds flock near / on sea-shore	03	03.00
Less or more fish catch than expected	03	03.00
Fishes disappear	04	04.00
Sound from <i>ghol</i> (<i>Protonebia dicanthus</i>)	02	02.00
Pomfret swims transverse (tilting)	06	06.00
Small burrowing fish, crab, etc. comes into the net	02	02.00

Table 20: Distribution of respondents based on observance of closed season

Observance of close season	Frequency	Percentage
Yes	84	84.00
No	16	16.00

4.3.2 Assessment of ITKs on maintenance of fishing crafts

Data presented in table 22(a) indicates the assessment of ITK on use of *chandrus* mixed with groundnut oil/cashew oil/ *undal* oil for maintenance of wooden crafts.

More than three quarter respondents (76.66%) rated ITK involving use of this treatment high with relation to availability of materials while two third of them (66.66%) rated this treatment as easy to follow. Use of this treatment was also rated as efficient by majority (66.66%) while 56.66 percent believed that it has scientific value. The cost effectiveness of the treatment was rated positively by 63.33 percent of the experts. Rating was moderate in terms of cultural appropriateness (60%) and environmental soundness (63.33%)

Data presented in table 22 (b) indicates the validity assessment of ITK on use of *chandrus* mixed with oil and lime to fix the small leaks in wooden boats.

Use of this treatment was rated high on efficacy (83.33%) and cost effectiveness (73.33%). It was also rated high (66.66) as far as scientific value is concerned, with regards to its ease in following (73.33%), cultural appropriateness (70.00) and environmental soundness (66.66).

4.3.3 Assessment of ITK on use of cotton to fabricate long line ropes

The data related to assessment of ITK on use of cotton to fabricate long line ropes is presented in table 23.

This ITK was rated high on availability of material (70%) and cost effectiveness (70%). It was rated poor in terms of efficacy (10%) and scientific value (50%). Assessment of this ITK against was rated moderate in terms of ease in following (60%), cultural appropriateness (56.66%) and environmental soundness (56.66%).

4.3.4 Assessment of ITK on tanning of cotton ropes by soaking in *ain* tree bark (*Pterocarpus hirsuta*) solution

Data related to the assessment of ITK on tanning of cotton ropes by soaking in 'ain' tree bark (*Pterocarpus hirsuta*) solution is presented in table 24.

This treatment was rated high on scientific value/logic (73.33%), availability of material (80.00%), efficacy (70.00), cost effectiveness (66.66%), ease in following (66.66%) and environmental soundness (76.66). 60.00 percent experts responded to it's cultural appropriateness.

4.3.5 Assessment of ITK on use of plastic drums / can and *pangara* (*Erythina indica*) wood plates as floats for bag-net and shore-seine respectively.

Data indicating assessment of ITK on use of plastic drums / can for bag-net and *pangara* (*Erythina indica*) wood plates for shore-seine is presented in table 25.

Use of plastic cans/drums for bag-net and *pangara* wood plates for shore-seine was rated high by experts on cost effectiveness (86.66%) and availability of materials (86.66%). It was rated moderate with respect to scientific value (60%) and efficacy (60%). Rating was high in terms of ease in following (70%). This ITK was rated low in case of cultural appropriateness and environmental soundness.

4.3.6 Assessment of ITK on use of cement rings and stones, iron chain and iron rings as sinkers for gill nets and dol net respectively

Data indicating assessment of ITK on use of cement rings for gill nets and stones, iron chain and iron rings for dol net is presented in table 26.

Table 21: Assessment of ITKs on material used for construction of fishing crafts

Sr. No.	ITK on material used for construction of fishing crafts	Response of experts on the assessment criteria (n = 30)						
		Scientific value / logic	Efficacy	Cost effectiveness	Availability of material	Easy to follow	Cultural appropriateness	Environmental soundness
1	Use of mango tree wood for keel and undal tree wood for rest of the boat.	09 (30.00)	09 (30.00)	26 (86.66)	27 (90.00)	13 (43.33)	11 (36.66)	06 (20.00)
2	Use of teakwood for entire boat.	23 (76.66)	23 (76.66)	--	10 (33.33)	11 (36.66)	09 (30.00)	12 (40.00)
3	Use of teakwood for keel and lower hull and babul tree wood for upper planks and deck beams.	20 (66.66)	23 (76.66)	22 (73.33)	21 (70.00)	16 (53.33)	09 (30.00)	11 (36.66)
4	Use of mango tree wood for entire boat.	03 (10.00)	08 (26.66)	22 (73.33)	22 (73.33)	16 (53.33)	09 (30.00)	04 (13.33)

(Figures in parentheses are percentages to the total number of respond

Table 22 (a): Assessment of ITK on use of *chandrus* mixed with either ground nut-oil / cashew-oil / *undal* oil for maintenance of fishing crafts

Sr. No.	Criteria	Response of experts on the assessment criteria (n = 30)
1.	Scientific value / logic	17 (56.66)
2.	Efficacy	20 (66.66)
3.	Cost effectiveness	19 (63.33)
4.	Availability of material	23 (76.66)
5.	Easy to follow	20 (66.66)
6.	Cultural appropriateness	18 (60.00)
7.	Environmental soundness	19 (63.33)

(Figures in parentheses are percentages to the total number of experts responded)

Table 22 (b) : Assessment of ITK on use of *chandrus* (a type of resin) + oil + lime to fix the small leaks

Sr. No.	Criteria	Response of experts on the assessment criteria (n = 30)
1.	Scientific value / logic	20 (66.66)
2.	Efficacy	25 (83.33)
3.	Cost effectiveness	22 (73.33)
4.	Availability of material	21 (70.00)
5.	Easy to follow	22 (73.33)
6.	Cultural appropriateness	21 (70.00)
7.	Environmental soundness	20 (66.66)

(Figures in parentheses are percentages to the total number of experts responded)

Table 23 : Assessment of ITK on use of cotton to fabricate long line ropes

Sr. No.	Criteria	Response of experts on the assessment criteria (n = 30)
1.	Scientific value / logic	15 (50.00)
2.	Efficacy	10 (33.33)
3.	Cost effectiveness	21 (70.00)
4.	Availability of material	21 (70.00)
5.	Easy to follow	18 (60.00)
6.	Cultural appropriateness	17 (56.66)
7.	Environmental soundness	17 (56.66)

(Figures in parentheses are percentages to the total number of experts responded)

Table 24 : Assessment of ITK on tanning of cotton ropes by soaking in *ain* tree bark (*Pterocarpus hirsuta*) solution

Sr. No.	Criteria	Response of experts on the assessment criteria (n = 30)
1.	Scientific value / logic	22 (73.33)
2.	Efficacy	21 (70.00)
3.	Cost effectiveness	20 (66.66)
4.	Availability of material	24 (80.00)
5.	Easy to follow	20 (66.66)
6.	Cultural appropriateness	18 (60.00)
7.	Environmental soundness	23 (76.66)

(Figures in parentheses are percentages to the total number of experts responded)

Use of cement rings for gill nets and stones, iron chain and iron rings for dol net was rated high with respect to scientific value (80%), availability of material (80%), cost effectiveness (76.66%), efficacy (73.33%) and ease in following (73.33%). Experts rated this ITK moderately against cultural appropriateness (53.33%) and environmental soundness (60%).

4.3.7 Assessment of ITKs on mesh sizes of major fishing gears

For the purpose of validity assessment of ITK's on mesh sizes of fishing gears, the major documented ITK on mesh sizes of fishing gears alone was considered and the results to this extent are presented in table 27.

A thorough examination of the data presented in table 27 indicates that the mesh sizes of the all fishing gears are rated high on scientific value and efficacy by the experts. The ITK on mesh size of hand trawl was rated moderately (60%) for both the criteria.

4.3.8 Assessment of ITK's on depths of operation of major fishing gears

For the purpose of validity assessment of ITKs on depth of operation of fishing gears, the major documented ITK on depth of operation of fishing gears alone was considered and the results to this extent are presented in table 28.

It is clear from data presented in table that the experts rate depths of operation of almost all fishing gears high on scientific value and efficacy. The depth of operation of hand trawl was moderately rated with respect to scientific value and efficacy.

Table 25 : Assessment of ITK on use of plastic drums / can and pangara (*Erythina indica*) wood plates as floats for bag-net and shore-seine respectively.

Sr. No.	Criteria	Response of experts on the assessment criteria (n = 30)
1.	Scientific value / logic	18 (60.00)
2.	Efficacy	18 (60.00)
3.	Cost effectiveness	26 (86.66)
4.	Availability of material	26 (86.66)
5.	Easy to follow	21 (70.00)
6.	Cultural appropriateness	12 (40.00)
7.	Environmental soundness	11 (36.66)

(Figures in parentheses are percentages to the total number of experts responded)

Table 26 : Assessment of ITK on use of cement rings and stones, iron chain and iron rings as sinkers for gill nets and dol net respectively.

Sr. No.	Criteria	Response of experts on the assessment criteria (n = 30)
1.	Scientific value / logic	24 (80.00)
2.	Efficacy	22 (73.33)
3.	Cost effectiveness	23 (76.66)
4.	Availability of material	24 (80.00)
5.	Easy to follow	22 (73.33)
6.	Cultural appropriateness	16 (53.33)
7.	Environmental soundness	18 (60.00)

(Figures in parentheses are percentages to the total number of experts responded)

Table 27 : Assessment of ITKs on mesh sizes of major fishing gears

Sr. No.	Major fishing gears and mesh sizes	Response of experts on the assessment criteria (n = 30)	
		Scientific value / logic	Efficacy
1.	Trammel net - (25 mm to 45 mm for inner net; 200 mm to 400 mm for outer net)	26 (86.66)	25 (83.33)
2.	Seerfish gill net – 180 mm	28 (93.33)	25 (83.33)
3.	Mackerel gill net - 65 mm	25 (83.33)	21 (70.00)
4.	Drift gill net - 150 mm	24 (80.00)	20 (66.66)
5.	Bottom gill net - 120 mm	22 (73.33)	22 (73.33)
6.	Dol net - 230 mm to 5 mm (mouth to end)	23 (76.66)	23 (76.66)
7.	Shore-seine (Rampani) – 10 mm to 50 mm (centre to side)	20 (66.66)	20 (66.66)
8.	Traditional trawler – 25 mm to 5 mm (mouth to end)	18 (60.00)	18 (60.00)

(Figures in parentheses are percentages to the total number of experts responded)

Table 28 : Assessment of ITKs on depths of operation of major fishing gears

Sr. No.	Major fishing gears and depths of operation	Response of experts on the assessment criteria (n = 30)	
		Scientific value / logic	Efficacy
1.	Trammel net – 10 to 15 fathoms	23 (76.66)	23 (76.66)
2.	Seerfish gill net – 25 to 30 fathoms	25 (83.33)	26 (86.66)
3.	Mackerel gill net - 7 to 10 fathoms	22 (73.33)	27 (90.00)
4.	Drift gill net - 15 to 22 fathoms	22 (73.33)	25 (83.33)
5.	Bottom gill net - 10 to 12 fathoms	23 (76.66)	25 (83.33)
6.	Dol net - 5 to 10 fathoms	20 (66.66)	25 (83.33)
7.	Shore-seine (Rampani) – 4 to 5 fathoms	20 (66.66)	26 (86.66)
8.	Traditional trawler – 7 to 12 fathoms	17 (56.66)	19 (63.33)
9.	Long line – 6 to 25 fathoms	23 (76.66)	25 (83.33)

(Figures in parentheses are percentages to the total number of experts responded)

4.3.9 Assessment of ITK's on preference time for operation of major fishing gears

For the purpose of validity assessment of ITKs on preference time of operation of fishing gears, the major documented ITK on preference time of operation of fishing gears alone was considered and the results to this extent are presented in table 29.

A detailed look at the table 29 indicates that the preference time for the operation of all the gears are rated high on scientific value and efficacy by the experts except the preference time for operation of hand trawl which was rated moderately by the experts.

The experts rated the preference time for operation of all fishing gears low with respect to the ease in following and cultural appropriateness.

4.3.10 Assessment of ITK's on specific location preferences for operation of major fishing gears

Data presenting assessment of ITK's on specific location preferences for operation of major fishing gears is given table 30.

Operation of shore-seine along stretches of sandy beaches; operation of spike dol net in waters where current force is high and operation of anchor dol net in waters where current force is comparatively less are rated high on scientific value and efficacy by the experts. But at the same time they are rated low with respect to cost effectiveness, ease in following and cultural appropriateness.

4.3.11 Assessment of ITK on use of bamboo cane basket for fish storing

Data presenting the assessment of ITK on use of bamboo cane basket for fish storing is given in table 31(a).

Table 29: Assessment of ITKs on preference time for operation of major fishing gears

Sr. No.	Major fishing gears and time preferences for their operation	Response of experts on the assessment criteria (n = 30)			
		Scientific value / logic	Efficacy	Easy to follow	Culturally appropriate
1.	Trammel net – 4 am to 8 am	20 (66.66)	19 (63.33)	09 (30.00)	12 (40.00)
2.	Seerfish gill net – 6 pm to 2 am	25 (83.33)	26 (86.66)	11 (36.66)	13 (43.33)
3.	Mackerel gill net – 4 am to 7 am & 6 pm to 9 pm	26 (86.66)	25 (83.33)	11 (36.66)	13 (43.33)
4.	Drift gill net - 6 pm to 6 am	24 (80.00)	25 (83.33)	13 (43.33)	13 (43.33)
5.	Bottom gill net - 5.30 am to 8.30 am	22 (73.33)	24 (80.00)	10 (33.33)	12 (40.00)
6.	Dol net – operated based on tidal energy (2 – 4 times a day)	30 (100.00)	25 (83.33)	12 (40.00)	18 (60.00)
7.	Shore-seine (Rampani) – 4 am to 7 am & 6 pm to 9 pm	24 (80.00)	23 (76.66)	12 (40.00)	18 (60.00)
8.	Traditional trawl – 3 am to 9 pm	16 (53.33)	19 (63.33)	12 (40.00)	12 (40.00)
9.	Long line – 4 am to 7 pm	22 (73.33)	26 (86.66)	12 (40.00)	14 (46.66)

(Figures in parentheses are percentages to the total number of experts responded)

Table 30 : Assessment of ITKs on specific location preferences for operation of major fishing gears

Sr. No.	Major fishing gears & specific location preferences for their operation	Response of experts on the assessment criteria (n = 30)				
		Scientific value / logic	Efficacy	Cost effective	Easy to follow	Culturally appropriate
1.	Operation of shore-seine along stretches of sandy beaches	28 (93.33)	25 (83.33)	12 (40.00)	12 (40.00)	12 (40.00)
2.	Operation of spike dol-net in waters where current force is high	24 (80.00)	21 (70.00)	09 (30.00)	10 (33.33)	07 (23.33)
3.	Operation of anchor dol-net in waters where current force is comparatively low	22 (73.33)	20 (66.66)	09 (30.00)	11 (36.66)	06 (20.00)

(Figures in parentheses are percentages to the total number of experts responded)

Use of bamboo cane basket for fish storage is rated high on cost effectiveness (80%) and availability of material (66.66%) by the fishery experts. But simultaneously experts have rated this ITK low with regards to scientific value, efficacy and environmental soundness. This ITK was rated moderately on ease in following (56.66%) and cultural appropriateness (50%).

4.3.11 Assessment of ITK on use of *boskul*, a bamboo cane basket used for live storage of crabs/ lobsters

Data presenting the assessment of ITK on use of *boskul*, a wooden cane basket used for live storage of crabs/ lobsters is given in table 31(b).

It is clear from the data given in the table that experts have rated this ITK high on scientific value (66.66%), efficacy (66.66%), cost effectiveness (70%), availability of material (66.66%) and ease in following (70%). Experts rated this

ITK moderately on cultural appropriateness (53.33%) and low on environmental soundness (40%)

4.3.12 (a) Assessment of ITK on fish preservation by sun drying on cemented ground, beaches, bamboo platform or coir mattress

Data indicating the assessment of ITK on fish preservation by sun drying on cemented ground, beaches, and bamboo platform or coir mattress is presented in table 32(a).

Fish preservation by sun drying on cemented ground, beaches, and bamboo platform or coir mattress is rated high on cost effectiveness (76.66) by the experts. It is rated moderately on scientific value (56.66%) and efficacy (60%). It is also rated high on ease in following (73.33%). While the ITK is again rated moderately with regards to cultural appropriateness and environmental soundness.

Table 31 (a): Assessment of ITK on use of bamboo cane basket for fish storing

Sr. No.	Criteria	Response of experts on the assessment criteria (n = 30)
i.	Scientific value / logic	05 (16.66)
ii.	Efficacy	05 (16.66)
iii.	Cost effectiveness	24 (80.00)
iv.	Availability of material	20 (66.66)
v.	Easy to follow	17 (56.66)
vi.	Cultural appropriateness	15 (50.00)
vii.	Environmental soundness	10 (33.33)

(Figures in parentheses are percentages to the total number of experts responded)

Table 31 (b): Assessment of ITK on use of *boskul*, a wooden cane basket for live storage of crabs/ lobsters

Sr. No.	Criteria	Response of experts on the assessment criteria (n = 30)
i.	Scientific value / logic	20 (66.66)
ii.	Efficacy	20 (66.66)
iii.	Cost effectiveness	21 (70.00)
iv.	Availability of material	20 (66.66)
v.	Easy to follow	21 (70.00)
vi.	Cultural appropriateness	16 (53.33)
vii.	Environmental soundness	12 (40.00)

(Figures in parentheses are percentages to the total number of experts responded)

4.3.13 (b) Assessment of ITK on fish preservation by salting and then sun drying

Data indicating the assessment of ITK on fish preservation by salting and then sun drying is presented in table 32 (b).

It is clear from the table that experts have rated this ITK high on scientific value (96.66%), efficacy (76.66%), cost effectiveness (76.66%), availability of material (66.66%), and ease in following (73.33%) and cultural appropriateness (66.66%). The response of experts was moderate with respect to environmental soundness.

4.3.13 (c) Assessment of ITK – fish dried during winter is of good quality than dried during summer

Data indicating the assessment of ITK – fish dried during winter is of good quality than dried during summer is presented in table 32 (c). Experts rated this ITK high on scientific value (80%) while they rated it low on efficacy (30%), cost effectiveness (33.33%), ease in following (36.66%), cultural appropriateness (40%) and environmental soundness (33.33%).

4.3.14 Assessment of ITK- effect of wind direction- winds blowing from northerly direction fetch more catch, while those blowing from southerly direction bring less catch

Data indicating the assessment of ITK - effect of wind direction- winds blowing from northerly direction fetch more catch, while those blowing from southerly direction bring less catch is presented in table 33. Experts assessed this ITK moderately on efficacy (53.33%) and low on other criteria such as scientific value (46.66%), ease in following (36.66%) and cultural appropriateness (20%).

4.3.15 Assessment of ITK on effect of water colour on fish catch-muddy water fetches more catch while clear water yields less catch

Data indicating the assessment of ITK on effect of water colour on fish catch-muddy water fetches more catch while clear water yields less catch is presented in table 34.

Table 32 (a): Assessment of ITK on fish preservation by sun-drying on cemented ground, beaches, bamboo platform or coir mattress

Sr. No.	Criteria	Response of experts on the assessment criteria (n = 30)
i.	Scientific value / logic	17 (56.66)
ii.	Efficacy	18 (60.00)
iii.	Cost effectiveness	23 (76.66)
iv.	Availability of material	17 (56.66)
v.	Easy to follow	22 (73.33)
vi.	Cultural appropriateness	17 (56.66)
vii.	Environmental soundness	14 (46.66)

(Figures in parentheses are percentages to the total number of experts responded)

Table 32 (b): Assessment of ITK on fish preservation by salting and then drying

Sr. No.	Criteria	Response of experts on the assessment criteria (n = 30)
i.	Scientific value / logic	29 (96.66)
ii.	Efficacy	23 (76.66)
iii.	Cost effectiveness	23 (76.66)
iv.	Availability of material	20 (66.66)
v.	Easy to follow	22 (73.33)
vi.	Cultural appropriateness	20 (66.66)
vii.	Environmental soundness	18 (60.00)

(Figures in parentheses are percentages to the total number of experts responded)

Table 32 (c) : Assessment of ITK - fish dried during winter is of good quality than dried during summer

Sr. No.	Criteria	Response of experts on the assessment criteria (n = 30)
i.	Scientific value / logic	24 (80.00)
ii.	Efficacy	09 (30.00)
iii.	Cost effectiveness	10 (33.33)
iv.	Availability of material	--
v.	Easy to follow	11 (36.66)
vi.	Cultural appropriateness	12 (40.00)
vii.	Environmental soundness	10 (33.33)

(Figures in parentheses are percentages to the total number of experts responded)

Table 33 : Assessment of ITK - effect of wind direction – winds blowing from northerly direction fetch more catch, while winds blowing from southerly direction bring less catch

Sr. No.	Criteria	Response of experts on the assessment criteria (n = 30)
i.	Scientific value / logic	14 (46.66)
ii.	Efficacy	16 (53.33)
iii.	Cost effectiveness	--
iv.	Availability of material	--
v.	Easy to follow	11 (36.66)
vi.	Cultural appropriateness	06 (20.00)
vii.	Environmental soundness	--

(Figures in parentheses are percentages to the total number of experts responded)

Table 34 : Assessment of ITK on effect of water colour on fish catch – muddy water fetches more catch while clear water yields less catch

Sr. No.	Criteria	Response of experts on the assessment criteria (n = 30)
1.	Scientific value / logic	25 (83.33)
2.	Efficacy	13 (43.33)
3.	Cost effectiveness	-
4.	Availability of material	-
5.	Easy to follow	10 (33.33)
6.	Cultural appropriateness	-
7.	Environmental soundness	-

(Figures in parentheses are percentages to the total number of experts responded)

It is evident from the data given in the table that the experts have rated this ITK high on scientific value (83.33%). However it has been rated low on efficacy and ease in following.

4.3.16 Assessment of ITK on effect of tides on fish catch and nets

Data indicating the assessment of ITK on effect of tides on fish catch is presented in table 35.

It is clear from the data given in the table that experts have rated the ITK – high tide yields more catch to dol net high on scientific value (83.33%) but moderate on efficacy (63.33). It has been rated low on ease in following (23.33%) and cultural appropriateness (20%). The ITK – high tide results in less catch to long line are rated low on scientific value and efficacy. Experts have rated the ITK- transition period between two tides yield more catch to gill net is rated moderately on scientific value (56.66%) but low on efficacy, ease in following and cultural appropriateness. While experts have rated the ITK-low tide yields more catch to shore-seine, provides more space for operation and facilitates hauling moderately on scientific value (60%) and low on efficacy and ease in following.

4.3.17 Assessment of ITK's on effect of lunar cycle on fish catch

Data indicating the assessment of ITK's on effect of lunar cycle on fish catch is presented in table 36.

It is clear from the table that the experts have rated the ITK- the period between 12th day to 3rd day of lunar cycle fetches more catch to dol net, the catch is moderate during the period 9th day to 11th day and less during 4th day to 8th day high on scientific value (80%) but low on efficacy (43.33%) and ease in following (26.66%). The ITK – the period between 4th day to 11th day of lunar cycle yields more catch to long line is rated high on scientific value (66.66%), moderately on efficacy (60%) and low on ease in following by the experts. While the ITK - new moon day and full moon day yield less catch to gill nets is rated low on scientific value efficacy and ease in following by the experts.

Table 35 : Assessment of ITKs on effect of tides on fish catch and nets

Sr. No.	Effect of tides on fish catch	Response of experts on the assessment criteria (n = 30)			
		Scientific value / logic	Efficacy	Easy to follow	Culturally appropriate
1.	High tide yields more catch to dol-net	25 (83.33)	19 (63.33)	07 (23.33)	06 (20.00)
2.	High tide results in less catch to long-lines	13 (43.33)	09 (30.00)	--	--
3.	Transition period between two tides yield more catch to gill-net	17 (56.66)	12 (40.00)	06 (20.00)	08 (26.66)
4.	Low tide yields more catch to shore-seine, provides more space for operation and facilitates hauling	18 (60.00)	14 (46.66)	08 (26.66)	--

(Figures in parentheses are percentages to the total number of experts responded)

Table 36 : Assessment of ITKs on effect of lunar cycle on fish catch

Sr. No.	Effect of lunar cycle on fish catch	Response of experts on the assessment criteria (n = 30)		
		Scientific value / logic	Efficacy	Easy to follow
1.	The period between 12 th day to 3 rd day of lunar cycle fetches more catch to dol net, the catch is moderate and less during the period 9 th day to 11 th day and 4 th day to 8 th day respectively.	24 (80.00)	13 (43.33)	08 (26.66)
2.	The period between 4 th day to 11 th day of lunar cycle yields more catch to long line.	20 (66.66)	18 (60.00)	11 (36.66)
3.	New Moon Day and Full Moon Day yield less catch to gill-nets.	13 (43.33)	11 (36.66)	09 (30.00)

(Figures in parentheses are percentages to the total number of experts responded)

4.3.18 Assessment of ITK's on indicators of cyclone

Data presenting the assessment of ITK's on indicators of cyclone is given in table 37.

It is clear from the table that experts have rated ITK's on indicators of cyclone such as winds gushing from south direction, exceptionally calm sea water, increase in turbidity of near shore water and accumulation of black clouds at horizon high on scientific value with moderate efficacy. Experts have rated the ITK-increase in intensity of currents as indicator of cyclone moderately (60%) on scientific value with low efficacy. While the indicator of cyclone-occurrence of mud into the nets in the form of flat nodules was rated moderately on scientific value and low on efficacy.

4.3.19 Assessment of ITK's on behavior of fish/ aquatic organisms before, after or during the cyclone or storm

The assessment of the given ITK on behavior of fish/ aquatic organisms before or during the cyclone or storm is presented in table 38.

It is evident from the table that the ITK- disappearance of fish during storm is rated high on scientific value (66.66%) and low on efficacy (33.33%) by the experts. While the ITK – exceptionally less or catch during or after storm is rated moderately on scientific value (53.33%) and low on efficacy (33.33%). While the ITK- curling and coming to the surface of *Mharuche* , a type of sea snake as indicator of cyclone is rated low on scientific value as well as efficacy.

4.4 Marketing pattern followed by respondents

An attempt was made to study the pattern of fish marketing followed by fishermen in terms of the time of sale and the avenues of sale. The data on marketing avenues is presented in table 39.

Table 37: Assessment of ITKs on indicators of cyclone

Sr. No.	Indicators of cyclone	Response of experts on the assessment criteria (n = 30)	
		Scientific value / logic	Efficacy
1.	Increase in intensity of currents	18 (60.00)	15 (30.00)
2.	Winds gushing from south direction	23 (76.66)	13 (43.33)
3.	Exceptionally calm sea water	22 (73.33)	14 (46.66)
4.	Increase in turbidity of near-shore water	21 (70.00)	14 (46.66)
5.	Accumulation of black clouds at horizon	20 (66.66)	13 (43.33)
6.	Occurrence of mud in the form of nodules in to the nets	18 (60.00)	11 (36.66)

(Figures in parentheses are percentages to the total number of experts responded)

Table 38 : Assessment of ITKs on behaviour of fish/aquatic organisms before, during or after cyclone

Sr. No.	Behaviour of fish/aquatic organisms as indicators of cyclone	Response of experts on the assessment criteria (n = 30)	
		Scientific value / logic	Efficacy
1.	Curling and coming to sea surface of 'Mharuche' a type of sea snake.	11 (36.66)	07 (23.33)
2.	Disappearance of fish.	20 (66.66)	10 (33.33)
3.	Transverse swimming or tilting behavior of black pomfret.	14 (46.66)	09 (30.00)
4.	Exceptionally less or more fish catch.	16 (53.33)	10 (33.33)

(Figures in parentheses are percentages to the total number of experts responded)

During data collection it was observed that almost all the fishers sell part of their catch in fresh form immediately and part of the catch they process and sell later. Table 39 shows that majority of the respondents (42.00 %) auctioned fish immediately after catch through agents or middlemen. Almost a quarter of them (26.00%) sold dried fish to traders. Slightly higher than one fifth (22.00%) and one fifth (20.00%) of them sold fish to agents and auctioned in market / shore, respectively. Co-operative society was the least preferred marketing avenue as only 13.00 percent respondents auctioned their catch through co-operative society.

4.5 Constraints faced by the respondents

Data presented in table 40 reveals that depletion of catch (64.00%) was the major constraint faced by fishers. Other constraints like inadequate extension service, low returns, pollution, low currents due to embankments and damage to nets were expressed by few respondents ($\leq 10.00\%$).

Table 39 : Distribution of respondents based on fish marketing avenues

(n = 100)

Marketing avenue	Frequency	Percentage
Auctioned through agent / middleman	42	42%
Sold to agents	22	22%
Dried fish sold to traders	26	26%
Auctioned in market / shore	20	20%
Auctioned through co-operative society	13	13%

Table 40: Constraints faced by the respondents.**(n = 100)**

Sr. No.	Constraint	Frequency of respondents
1.	Depletion of catch	64 (64.00)
2.	Inadequate extension service	10 (10.00)
3.	Low returns from fish	10 (10.00)
4.	Pollution	07 (07.00)
5.	Low currents due to embankments	05 (05.00)
6.	Damage to nets	04 (04.00)

(Figures in parentheses are percentages to the total number 100)

DISCUSSION

5. DISCUSSION

The findings of the study are interpreted and discussed in this chapter in the same order as that followed in results chapter.

5.1 Profile characteristics of the respondents

On the basis of the data presented in table 3, a profile picture of the respondent fishers can be arrived at. Analysis of the profile characteristics of the respondents' revealed that majority of the fishers belonged to the middle age category. Most of them were married. Majority had formal schooling up to primary level and were thus literates. This can be attributed perhaps to the better availability of education facilities in respective regions. Most of the fishers have nuclear and large (> 4 members) families and dwell in *pucca* houses. This points out that the income from the fishing is enough for the fishers to sustain living separately in *pucca* houses. Large family trend of fishers indicates their ignorance of family planning. Over three fourths of fishers were having fishing experience of up to 20 years suggesting that the time period is enough to acquire considerable indigenous knowledge on aspects related to fishery management.

5.2 Indigenous technical know-how on fishery management

5.2.1 ITKs on fishing crafts.

The coast of Maharashtra can be divided into two zones, namely, North Konkan Coast - comprising Thane, Greater Mumbai and Raigad districts and South Konkan Coast - comprising Ratnagiri and Sindhudurg districts. This division is based on *distinctive ecological features and fisheries resources*. North Konkan coast is characterized by wide and shallow continental shelf and swift currents while South Konkan coast is characterized by narrow continental shelf and mild currents. These factors are reflected in their choice of crafts and gears. The choice of a particular traditional technology depends on a number of local factors such as the profile of the coastline, tidal effect, width of the

continental shelf, nature of the fish resources, wind and weather conditions, availability of materials and fabricating skills (Venkataraman, 1996). The traditional technology we see today has evolved continuously over the years. Indigenous crafts have undergone changes in the kind of wood used in it.

5.2.1.1 Construction material used for boats.

The choice of wood for construction of fishing crafts depends on location needs for required strength, availability of material, convenience in building and cost factor. These factors are also reflected in the study results (table 4) as the main reasons for choosing particular wood for constructing either entire boat or parts thereof.

The choice of teakwood as construction material by majority in Greater Mumbai district (table 4) is quite logical. The large teakwood boats of Greater Mumbai coast are just right for capturing the large shoals of Bombay-duck, which are available close to the shore, as the continental shelf is wide off this part of the coast. Teakwood is sturdy and durable. It is able to sustain swift currents for a long time. Therefore, majority of boats (56%) in Greater Mumbai meant for bag-net fishery, gillnetting and traditional trawling are constructed of teakwood.

About one-third (34.00 %) crafts in Greater Mumbai district are constructed of combination of teakwood and 'babul'. In this case, teakwood is used for constructing keel and lower hull while babul is used for upper planks and deck beams. Fishers observed that babul wood is flexible; therefore it absorbs shock and does not break easily.

About 8.00 percent of the total crafts, those used for long lining are constructed of combination of teakwood and mango wood. Teakwood is used for upper hull and mango wood is used for lower hull and keel. The rationale behind this is that the entire keel can be carved out from single mango trunk.

In Sindhudurg district, majority of the gill-netters and the *hoda* (70%) meant for the operation of the rampani are constructed of mango wood and *undal* tree wood. Only the keel of these boats is made up of mango tree wood, as it is possible to carve out whole keel from the mango tree trunk. The planks for hull and deck are made up of *undal* tree wood, as it is cheap and easily available. The south Konkan area is abundant with trees of mango and undal.

About a quarter of the boats (26%) mainly the small dugout canoes used for gill-netting are constructed of only mango tree wood.

Thus a striking difference can be noted in type of wood used for the construction of the crafts. Most of the crafts in Greater Mumbai district are made up of teakwood and rest with combination of teakwood with other types of wood. While those of Sindhudurg district are made of mango tree wood in combination with *undal* tree wood or only of mango tree wood. This can be attributed to the fact that fishers being closer to commercial center like Greater Mumbai are fully aware of the advantages of teakwood and are financially sound to afford it. On the other hand fishers of Sindhudurg district make exclusive use of mango tree and *undal* tree wood, which are easily available due to its abundance in the locality and are cheap.

5.2.1.2 Dimensions of fishing crafts

For the sake of convenience and easy understanding, the results pertaining to OAL, width, depth, fish hold capacity are combined for a particular type of craft and discussed accordingly.

As described in the results chapter, wide variation was observed with respect to the dimensions of the different fishing crafts. The dimensions of the fishing crafts in terms of overall length, width, depth and fish hold capacity vary according to the suitability in operating the number and particular type of fishing gear in the given environment, available fish resources, depth of operation, cost of construction, availability of materials and fishers' experience

based on continuous trial and error. For example, the crafts meant for bag-net fishery are generally bigger with maximum OAL up to 42 ft and width up to 16 ft. These boats can easily carry two to three bag-nets at a time to be fixed against stakes simultaneously at different stations.

Operation of '*Rampani*' involves use of non-motorized boat known locally as '*hoda*', which are operated nearby shore. These crafts can carry *rampani* net easily for operation. They have steep bow and are generally 'v' shaped for good speed because after the shoal has been sighted the fishers have to pay the net in semi-circular fashion around the shoal very quickly.

Traditional fishing crafts, in reality, are an extension of the fisherman's body. By themselves they have very little chances of success without the specific skills of the fishers who use them.

5.2.2 Maintenance of crafts

Fishers of Sindhudurg and Greater Mumbai districts invariably give the treatment of '*chandrus*' and oil such as groundnut oil, linseed oil, undal tree oil, or cashew oil, to the crafts. This treatment is done to increase the durability of the wooden crafts. This may be due to the fact '*chandrus*' a type of resin extracted from trees unknown to fishers and oil when boiled form a sticky liquid of good strength which gives compactness to the wood. But this is hypothetical and further study is required to find out the various properties of '*chandrus*'.

Hale (1998) reported that adhesiveness, insolubility in water, poisoning properties, plasticity, vitreosity, calorability are qualities which apply to a greater or lesser extent to all resins.

Similarly to fix the small leaks in wooden boats fishers make paste of undal tree oil, *chandrus* and lime mixed in equal proportion and apply to leaks, which takes about two hours for drying. Again this might be due to forming of powerful adhesive, as lime is well known for its cementing properties.

5.2.3 ITKs on fishing gears

As described earlier, the traditional fishing technology adapts and evolves all the time. The choice of gear also depends upon the nature of coastline, tidal effect, extent of surf action and availability of fish resources.

5.2.3.1 Dol net

The dol-net fishery in Greater Mumbai continues to be widely used as it is the best way to catch the Bombay-duck. Dol-net is operated by five different methods with respect to the mooring material used.

In Greater Mumbai, spike or khunt type of dol-net is popular. Spike dol-nets are used in locations where the currents during the tides are swift and straight, so that they can withstand the force of water during tides. Two to three nets are operated simultaneously at a depth of 5-20 fathoms, with a difference of couple of fathoms depth between two stations. The nets are operated two to four times a day depending upon the swiftness of the current. Some fishers operate the dol-nets two times against high tide, or four times against high and low tides.

There is one interesting feature as far as the time to set the dol net for fishing is concerned. Suppose today the dol net is fixed at start of high tide at 6 am, tomorrow morning fishers will fix it at 6.50 am. The earth makes a complete rotation once every 24 hours. This constant motion puts different sections of earth's oceans under the moon's gravitational influence during the course of a day resulting in daily cycle of two tides and two low tides. However, this tidal cycle occurs not every 24 hours, but every 24 hours and 50 minutes. The extra 50 minutes is due to the rotation of the moon around the earth once each month. Therefore, the moon has changed position in relation to a spot on the earth during the 24 hours in which the earth makes a complete rotation. As a result it takes on average of 50 minutes extra each day for a spot on the catch to 'catch up with' the moon. Dol nets thus make appropriate use of tidal energy to catch fish.

Anchor dol nets are used where the swiftness of currents during the tides is comparatively low either due to man-made or natural reasons. The fishers of Jamshedji Bunder in Greater Mumbai district resort to anchor dol-nets. This is because the Indian Navy has constructed an embankment laterally nearby it, for some of its reasons. This has hampered the flow of water currents in to the fishing ground. Therefore, fishers operate dol-net against low tide as they believe the receding water during low tide has comparatively more force than incoming high tide. This reflects the ability of the fishers to adapt to the local conditions if situation demands.

5.2.3.2 Gill-nets

Gill-net fishery also forms important traditional fisheries off Greater Mumbai coast. They are of various mesh-sizes and operated at various depths to target the specific fish species.

5.2.3.2.1 Trammel nets

Trammel nets are operated in 5-10 fathoms depth. Penaeid prawns such as *Metapenaeus monoceros*, *M. brevicornis* and *M. stridulans* are known to be found along inshore waters off Bombay coast (Bal and Rao, 1990). The mesh size of these nets is suitable to catch these prawns. The net is operated during 5 am - 8 am. Fishers believe that prawns are available during early morning hours.

5.2.3.2.2 Drift gill-nets

Drift gill-nets used for catching pomfrets and seerfish are operated at 15-35 fathoms depth. Bal and Rao (1990) have reported occurrence of juveniles of pomfrets in 15-20 fathoms depth. The mesh size of gill-nets meant for pomfrets is about 120 mm.

Drift gill-nets for seerfish have mesh size about 150 mm, and are operated at about 35 fathoms. Bal and Rao (1990) reported that fishing activity

is generally confined to 20 to 50 m depth range for seerfish. Drift gill nets are generally operated during 6 pm - 6 am.

5.2.3.2.3 Bottom set gill-nets

Bottom set gill-nets have mesh size varying from 75 mm - 200 mm. They are used to catch bottom dwelling fishes such as catfishes, sharks, lobsters and crabs. They are operated at 10-15 fathoms depth during 5.30 am to 8.30 am.

In the inshore fishing, shore-seines, cast nets and gill-nets are used and crabs along with fish groups are landed (Bal and Rao, 1990).

Bottom set gill-nets are generally operated on rocky bottom to catch rock lobster. As the name 'rock lobster' suggests, these are supposed to be restricted to rocky areas, where they inhabit the crevices.

5.2.3.3 Traditional trawls

These nets are relatively small sized with 25 to 100 ft length, 12 to 40 ft width and 8 to 12 ft height. These small size trawls are efficient to catch fish in inshore waters. Mohite (1999) reported that small sized hand trawlers operate near-shore upto a depth of 18-20 m in Greater Mumbai district. The operation of traditional trawlers or hand trawl in 7-12 fathoms depth conforms to the above observation.

5.2.3.4 Long line

The long lines are operated at a depth of 6-25 fathoms. These are aimed to catch fishes such as catfishes, sharks, eels, grouper, Indian salmon, etc. They are operated during 4 am - 7 pm followed by 6 am - 11.30 am.

Long-lining for bottom species on continental shelf areas is undertaken for a wide range of species (Sainsbury, 1996). Bal and Rao (1990) reported that long-lining is commonly used to catch catfishes.

Sindhudurg district:

5.2.3.5 *Rampani*

The operation of *rampani* in this area is a very good example of fishers' teamwork with regards to the management of *rampani* fishery and sharing of benefits. The wide sandy beaches of Sindhudurg district are ideal for the operation of shore seines such as '*Rampani*'. The *rampani* is popularly operated at 4-5 fathoms depth, to catch shoaling fishes.

Sainsbury (1996) has reported that extensive beach seine fisheries have existed historically in the Indian Ocean. Shore-seine is probably one of the oldest forms of surround net fishing being used extensively where the fish are migrating along or shoaling near beaches with adjacent shallow waters and clear bottom.

Mackerel and oil sardine shoals enter the western coast of India quite regularly in the post-monsoon months every year. Bal and Rao (1990) reported that *rampani* is important gear employed to catch the shoaling fishes such as mackerel and sardines, along the western coast of India.

Fishers identified mackerel shoal as blackish coloured, oval shaped and that swimming with upturned mouth, while that oil sardine shoal as fast swimming shoal with front side of the shoal thrusting forward and coming above the water surface. Bal and Rao (1990) reported that a mackerel shoal can be spotted from a distance during day time as a dark patch in arrow head formation, moving at a speed of 8 to 10 miles an hour. This confirms to the fishers' way of locating mackerel shoal. They also reported the flipping type shoal of oil sardine, which is characterized by jerking movement. Flipping shoals of oil sardine occur commonly in the morning and at night.

The *rampanis* are operated whenever a shoal is sighted, but as such they are operated in morning and during late evening when fish shoals occur commonly. According to Nomura (1958) the sardines (*Sardinops*

melanosticta) and probably many other species are most active during the twilight of morning and evening.

5.2.3.6 Gill-nets

Gill-nets in Sindhudurg district are operated to catch fishes such as mackerel, seerfish, and pomfret and prawns. Venkatraman (1996) reported that small gill-nets, beach seines and boat seines are ideal to catch the fish from Ratnagiri to Quilon.

The operational depth of gill-nets is adjusted as per requirement with ropes that are attached to the master floats. Generally floats are reduced after the end of fishing season of target fish species.

5.2.3.6.1 Mackerel gill-net

They are operated generally in 10-15 fathoms depth. As described earlier mackerel occur in inshore waters. They are operated during 4 am - 7 am. Fishers observed that most of the fishes occur during early morning. This might be due to availability of fish food organisms at particular that particular time.

5.2.3.6.2 Seer fish gill-net

Mesh size varies from 60-70 mm, and are operated beyond 20-25 fathoms. As described earlier, the fishing activities for seerfish are generally confined to 20 to 50 m depth. They are generally operated during 6 pm to 2 am.

The preference time for fishing in both districts is almost similar, from evening to early morning. Fishers believed that seerfish are generally available at this time unlike other fishes, which occur at morning or daytime. This might be also due to the availability of fish food organisms at particular that particular time.

5.2.3.6.3 Trammel nets

These are three layered nets popularly known as *disco* nets in Sindhudurg. These are operated in 10-15 fathoms depth popularly, during 4 am - 8 am. Feeding migration of penaeid prawns in inshore waters is common. It is well known that juveniles of penaeid prawns occur in brackish or estuarine waters. Small *disco* nets operated on dug-out canoes are employed to catch prawns.

5.2.3.6.4 Pomfret gill-nets

Gill-nets used for catching pomfrets have mesh size of about 50 mm and are generally operated at 20 fathoms depth. As described earlier small pomfrets occur in inshore waters upto 20 fathoms depth. Like seerfish gill-nets, pomfret gill-nets are also operated during evening upto early morning. This practice is common in both districts.

As general in both districts, the operational depth of gill-nets is adjusted with increase or decrease in number of floats and sinkers as per availability of the fish.

The operational depth is also adjusted with ropes, which are attached to the master floats. Generally floats are reduced after the end of fishing season of target fish species.

5.2.3.7 Long lines

Fishers operate long lines in about 30-50 fathoms depth. They are usually meant to catch catfishes and sharks. Few fishers lay the line in such a way that half of the total hooks lie on muddy bottom and half on the rocky bottom, the demarcation of which according to them is in 30 fathoms depth. This may be attributed to availability of different fishes on respective bottoms. For example, catfishes are found over muddy bottoms. This may due to the fact that they are detritus feeders. Fishers are well versed with the nature of the seabed.

5.2.4 Maintenance of gears

Long line ropes are made up of cotton. So as to increase durability, they are subjected to colouration or tanning. For this purpose the bark of 'ain' tree is used. The bark consists of tannin, a substance which is generally used for colouration and dyeing. The use of bark of various trees for tanning of the nets is reported in southeast Asia. Burkill (1935) mentions several species of trees producing resinous bark used for tanning fish nets. The bark of *Eugenia palembanica* tree, for example, is used for tanning nets and caulking boats in Penang in Malaysia.

Tanning is done to increase the durability of the nets by waterproofing them. Tanning also helps to ensure specific colour of net similar to the given environment. This helps in deceiving the fish to pass through the nets.

5.2.5 Use of indigenous material for fabrication of gear, floats and sinkers

5.2.5.1 Indigenous material for net fabrication

The use of indigenous material for fabrication of net is not common. The only indigenous material used for the fabrication of nets was in the form of cotton. The fishers operating long lines in Greater Mumbai district used cotton for long line ropes. Cotton is used because the ropes easily sink to the bottom by absorbing water. This property of cotton helps the fishers to pay the long lines in the water in short time.

5.2.5.2 Indigenous material for floats

Seventeen percent fishers used indigenous material for floats in the form of plastic cans or drums (table 10). Plastic cans / drums are mainly used as floats for dol-nets. They are easily available at very cheap rates sometimes without any cost and keep the net efficiently floating.

A few fishers used floats made up of *pangara* tree wood plates for *rampani*. These floats are made from *pangara* tree, *Erythina indica*. These floats are in the form of small plates, are very light, thus indicating its good water buoyancy. These are attached to the head rope in large numbers. Due to its lightness, these floats make splashing sound on the water surface, when the net is being hauled. This splashing sound forces the fish shoal to move towards the shore.

5.2.5.3 Indigenous material as sinkers

Indigenous material in the form of cement rings, stones, iron chains, iron rings, bricks and tiles are commonly used as sinkers for the nets. Fishers resorted to these materials due to their easy availability, low or no cost, and to avoid poaching of expensive ^{sinkers} ~~floats~~. Iron chains are used as sinkers in dol- net. Cement rings are locally prepared by fishers themselves. Cement is poured in required float mould. Hole is made in them with small PUC pipes of required diameter. Stones, bricks and tiles are used as sinkers for gill-nets.

5.2.6 Fish Storage And Preservation

5.2.6.1 Fish Storage

The fishers of the Greater Mumbai and Sindhudurg district commonly use bamboo cane baskets to store the fish temporarily. These baskets are cheap, easily available and light.

Few fishers stored their catch of lobsters, crabs in special conical bamboo cane baskets known locally as *boskul*. Three ropes are run around the basket to meet at the top. They act as slings. The basket is covered on top by a piece of net. These baskets are used to temporarily store crabs or lobsters still they are sold. The baskets are kept submerged in creek water; otherwise water is sprinkled on it frequently. Fishers know about crawling habit of crabs and lobsters and hence use *boskul* to prevent the escape of crabs and lobsters.

5.2.6.2 Fish Preservation

Sun drying was the most common method of fish processing followed by fishers of Greater Mumbai district. Fishes such as *dhoma*, anchovies and prawns (*Acetes indicus*) are dried on beaches and cemented ground.

Balachandran (2001) reported that drying is one of the oldest known methods of preservation of food. Sun drying is carried out in the open air using the solar energy to evaporate the water in the food. The natural air currents carry away the evaporated water.

Drying of the fish involves the principle of reducing the water activity of a fish to a level where microorganisms responsible for spoilage cannot survive.

In Greater Mumbai, fishes such as Bombay-duck and ribbonfish are invariably dried on bamboo scaffolds. The fishers are well aware of the peculiar morphological characteristics of the fish and utilize the same to facilitate the drying. Bombay-ducks are hung to platform by inserting the sharp teeth of two fishes into each other while the ribbonfishes are hung to the platform by tying loose knot of caudal fins of two fishes due to its long tails.

This type of drying ensures uniform and three-dimensional drying, without contamination of sand and other extraneous materials, and the shelf life of such products is about two to three months (Govindan, 1985).

In Sindhudurg district, the fishers most commonly follow salting followed by sun drying. It is also known as dry-curing or salt drying.

Fishermen dry fishes such as mackerel, sardine, *dhoma* by this method. They first wash the fishes with seawater. Layers of salt and fish are kept in bamboo cane basket for about two days. The fish are overturned after two days and again salted with fresh salt. Generally salt is used in 1:5 ratio (salt to fish). Afterwards the fish are again washed with water and then dried on

sandy beach. During salting process salt enters the fish flesh and water moves out due to osmosis. Salting facilitates subsequent drying as much of the moisture is already removed.

5.2.6.3 Preparation of fish by-products

As described earlier, the shark liver oil is obtained by storing the liver for few days with salt in a closed container and afterwards heating in a vessel. Heating results in thermal rupture of liver cells releasing oil. The oil thus formed is collected and sieved. The oil is of unhygienic quality and is generally used in application to the boats, i.e., the *chandrus* with oil treatment as described earlier.

Balachandran (2001) has reported similar method of extraction of shark liver oil wherein heating is continued till the liver disintegrates completely and oil floats on top. The report conforms to the method of fishers.

5.2.7 ITKs on effect of wind direction on availability of fish

Most of the practical knowledge of fish behavior and availability to gear is location, species, season and gear specific. It is desirable to collect the experiences of experienced fishers, re-evaluate and record these in writings for benefit of future fishers as well as for fisheries research. It is indeed expected that the observations of fishers would provide valuable suggestions for further research by fisheries scientists. Much of the knowledge of fish behaviour and availability to capture in relation to weather and ocean conditions is proprietary and personal. Wide use of this knowledge separates the good shipper from the mediocre one.

The most important weather element at sea is wind. Its main effects on the ocean are the generation of surface waves and currents in the surface layers.

The movement of fish is dependent on water current and the latter is dependent on the direction and intensity of wind. Harden Jones et al. (1976)

believed that most fish movements and migrations are related to currents. Gawn (1950) and Saunders (1951) reported that the fish usually heads to the currents. If the current is strong, most fish head to the current, whereas in weak currents other directions and orientations occur. They further reported that the movement of several species is affected by light and by currents, in light the fish swim against the current, whereas in darkness they drift with it.

Fishers observe the present and near past winds and utilize past experiences of the winds and of the relationship between wind and fish availability for their tactical fishing decisions. In Greater Mumbai and Sindhudurg districts, most of the fishers believed that winds blowing from north direction fetch more catch while those blowing from south direction bring very less catch.

Few fishers opined that moderate fish is expected when winds blow from west. Very few fishers (2%) of opinion that more fish is obtained when wind blows from east direction. While winds blowing from any other directive other than mentioned, did not have any significant effect on fish catch.

Detailed studies on currents are essential to understand mechanisms of fish movements and migrations. Scientific studies of wind in relation to fish behaviour are few. However, there are two studies of the effects of wind on catches, one at Hamburg (Walden and Schubert, 1965) and another at Lowestoft. Two papers from Lowestoft (Harden Jones and Scholes, 1980) dealt with trawling for bottom fish, mainly plaice and cod. These studies were prompted by the belief of Lowestoft fishers that fewer fish are caught with winds between northwest and northeast ('Starvation winds').

Harden Jones and Scholes (1980) found that catches of plaice in the Southern North Sea were low during northerly winds all the year round, whereas catches of cod were higher with these winds, mainly in autumn and winter. The authors of this study pointed out that a relationship between the

catches and winds might arise if a given wind direction prevails during a spawning aggregation season of the species.

Walden and Schubert (1965) reported that no good catches of herring could be expected off the coast of East Anglia with easterly winds. Westerly winds are supposed to drive herring out from Norwegian Fjords, whereas easterly winds are related to good catch there. West winds are also favourable for good catches off the Danish West Coast.

Nearly every fisher is convinced of that some relationship exists between wind direction and availability of fish. Unfortunately for various reasons this varied knowledge is not scientifically tested. This knowledge pertains mostly to local (coastal) conditions and cannot be generalized.

5.2.8 Water colours and availability of fish

Most of the fishers (82.00%) opined that more fish catch occurs in the muddy waters while about 75.00 percent experienced low catch in clear glossy water (table 15).

Some fishers came across moderate fish catch in blue coloured water particularly such as seerfish and sardines. While some believed that more fish occur in greenish water.

In sea, water having different colours appears at different times. While fishing, fishers observe water of different colours and through experience; they have gained knowledge about the relationship between the colour of the water and availability of fish.

Muddy water is due to the presence of the suspended particles and bottom fauna of diatoms and zooplankton. Zooplankton is the main food for most juveniles and small pelagic fish. Its abundance can be related to the occurrence of more fish in muddy waters. Another ecological factor, which might be related to more fish availability in muddy waters, is water clarity. Gill-nets are more efficient in turbid waters. This may be because the efficiency of sight

feeders is reduced as the turbidity increases. Fishes such as catfishes are bottom feeders and their abundance in water can be related to more availability of fish food organisms.

The occurrence of very less fish in clear or glossy water indicates scarcity of fish food organisms in such waters. Murphy (1959) found that the number of albacore (*Jhunnus alalunga*) taken by gill-net on the surface was seriously affected by the transparency of the water.

Water colour and especially content of plankton have also been found a suitable surface water type indicator (Macumo, 1957).

Some fishers reported occurrence of fish in bluish water also such as seerfish and sardine. This may be attributed to availability of their food organisms in such waters.

Seerfish shoals (*Scomberomorus lincolatus*) are known to be very and composed of several thousand individuals of a single age group (Williams, 1962).

May be these shoal themselves are imparting bluish colour to the water. But this is a hypothetical relationship.

Sometimes fluorescent bacteria are present in the water due to which water is illuminated. This effect is more pronounced during New Moon Day when moonlight is absent. Fishes are able to see the nets and avoid crossing it, in case of gill-nets.

5.2.9 ITKs on effect of tides on fish catch and nets

The moon and sun have a dramatic effect on the earth due to their combined gravitation force they place on anybody of water. The oceans are most noticeable. The gravitational force causes the oceans of the world to move resulting in what we refer as tides. The effect of moon is more dominant due to its proximity to the earth.

In 24 hours, two high tides and two low tides occur, each lasting for about 6 hours. When the tide is rising, it is known as flooding, when tide is falling it is known as ebbing.

Majority of fishers among dol net operators reported that high tide yields more fish catch. Dol net is bag net, which is stationary and fixed with mouth facing the currents either during incoming or receding tides. High tide causes increased water force. So the fish catch is more during high tide. For low tide it is vice versa. But few fishers told low tide yields more catch to dol net. This is location specific where the effect of incoming tide is affected by construction of embankment.

Most fishers operating gill-nets especially surface gill-nets believed that more fish catch is fetched during transition stage of low tide. Because the gill-nets gets disturbed due to increased water force during high tides.

Contradictory to this observation of fishers, some fishers observed good catch to gill-nets during high tide. Gill-net catches active fish that swims into the net. Faster currents due to high tides may increase this activity.

Fishers operating shore-seine i.e. 'rampani' opined that low tide yields more catch to rampani, facilitates it's hauling and provides more space for its operation.

Although the rampani is operated whenever the fish shoal is sighted nearshore receding water during low tide brings the shoal to the centre when the net is being hauled. There is no increased water force during low tide therefore hauling is easy. And receding water provides more space for the operation of shore-seine.

Majority of fishers operating long lines experienced less catch during high tide. This may be also due to increase water force during high tide.

This effect may be limited to long lines operating in depths of less than 20 fathoms.

Fish are easier to catch when they are feeding and its tide and currents that dictate this. As the water begins to rise, fish may get confused in the turbulent water. Also the fish are attracted to bait mainly by olfactory stimuli. The emission of attractive olfactory stimulants from the bait may decrease with fast currents during high tide.

Almost all the fishers operating traditional trawlers experienced difficulty in hauling the net during high tide. The fishers haul these trawl nets manually. It is obvious that more efforts would be required to haul the net during high tide due to increased water force. Also the nets are likely to be damaged.

5.2.10 ITKs on effect of lunar cycle on fish availability.

Dol net fishery, which makes exclusive use of tidal energy for its operation, is mostly influenced by the lunar cycle.

All the fishers operating the dol net stated that more fish are caught during 12th day to 3rd day of lunar cycle, i.e. between '*Dwadashi*' to '*Tritiya*' of lunar month (calender), while the fish catch is moderate during 9th day ('*Navmi*') to 11th day (*Ekadashi*) of lunar cycle. This because there is more force to water during days which create faster currents.

Dol nets are operated four times during these days. The period of tidal slackening (no movement of water between and tides) is very less i.e. approximately 20 minutes.

Fishers reported very less catch fish catch during 4th day ('*Chaturthi*') to 8th day (*Asthami*) of lunar cycle. There is no force to water during these days and tides generate very slower currents. At these times, least difference between low and high tide is noted. In fact, some fishers do not operate dol net during this period.

Lunar cycle thus plays an important role in ensuring the success of the dol net.

On the other hand, fishers operating long lines experienced comparatively more catch during 4th day to 11th day of lunar cycle due to slower currents.

Most of the fishers operating gill-net observed less catch on Full Moon Day and New Moon Day. During these days spring tides occur. Spring tides are when the water level rises to its highest point for that particular lunar cycle due to combined gravitation pull of sun and moon. There are faster currents during these days, which might be disturbing the gill-nets.

But this contradicts the observation by Laevastu (1961) who reported that catchability of gill-nets during the night is related to the lunar calendar, the largest catches being usually made during the new moon.

5.2.11 ITKs on indicators of cyclone/storm

There was a wide variation in the opinions expressed by the fishers regarding indicators of cyclone.

Most of the respondents observed increase in intensity of water currents as indicator of occurrence of storm. Some reported that wind gushing from south as the sign of occurrence of cyclone. Few fishers stated that when a cyclone is expected, seawater remains exclusively calm. Others reported that increase in turbidity of near-shore water and accumulation of black clouds at horizon as an indication of occurrence of storm.

These are few of the multiple views expressed by the fishers regarding the indicator cyclone.

The occurrence of cyclone as such is not common on west coast of India. And many of these phenomenons are associated with occurrence of storms during onset of southwest monsoon. As described elsewhere, these are

the observations made by fishers pertaining to specific location and cannot be generalized.

Suppose few fishers had stated that nearby features in sea such distant islands or rocks appears clear and very near. Such physical features may not present nearby every fishing village.

5.2.12 ITKs on behavior of fish or other aquatic organisms before, during or after cyclone

Some fishers have indicated the curling behaviour of sea snake locally called *Mharuche* in Sindhudurg district as indication of occurrence of storm. Few fishers have reported the disappearance of fish during or after cyclone. Some have reported that black pomfret swims transversely during storm. Other indications of occurrence of cyclone reported by fishers included flocking of small birds unusually nearby coast and croaking sound from *ghol* (*Protonebia dicanthus*).

In world, several reactions of fish to storms have been reported, for some of which a hypothetical cause can be guessed at.

Laevastu (1961) reported that fishers know from their observations and practice that storms have great influence on the occurrence and migrations of fish.

Robins (1957) reported that the storms are limiting factors in the shoreward distribution of many fish. Porpoises in Mexican waters have been reported as leaving areas several hours before the onset of bad weather (Bernard, 1973). Hardon Jones and Scholes (1980) quote an observation that herring and pilchards off Cornwall coast move from shallow to deep water before the onset of storm ten or more hours before any of its violence could reach their locality.

Laevastu (1993) reported that the fish reactions before storms could be caused by either internal waves excited by moving surface pressure systems or changes of currents caused by same phenomenon.

5.2.13 Observance of closed season

Most of the fishers in both district observed closed season starting from around June 7 to *Narli Poomima* (full moon day occurring around second week of August). They restart their fishing activities after *Narli Poomima*. Fishers worship the sea by offering coconuts, which are dispersed in the sea. They consider *Narli Poomima* as auspicious day to start fishing.

The sea, which remains heavy throughout the southwest monsoon, begins to calm down from this day onward. They observe closed season mainly due to this reason.

5.3 Assessment of documented ITKs

Recognizing the general value of IK is important. But at the same time assessing specific ITK for application in development projects is equally significant. To use ITK in development projects we must be selective as some ITK is out of use. Therefore, methods should be established to assess ITK to confirm its validity. Assessing IK means identifying potentially useful ITK and evaluating its effectiveness.

In view of the above and in the light of the study objectives, it was, therefore, felt essential to assess the documented ITK's on fishery management of coastal Maharashtra in order to establish their rationale and validity.

For the sake of convenience in interpretation, the assessment of ITKs against various criteria by experts was considered as assessment indicators and accordingly ratings were grouped as high (more than 70%), moderate (50-70%) and low (less than 50%).

5.3.1 Assessment of ITKs on fishing crafts

Most of the experts have indicated the superiority of the teakwood as boat construction material in terms of its efficiency and scientific value. This may be due to the established fact that teakwood is essentially a sturdy and durable construction material. But at the same time it had been rated low on availability of material and ease in practicing. At the same time it is not cost effective. Use of combination of teakwood for keel and lower hull and *babul* tree wood for upper planks and deck beams have been judged high on efficacy and scientific value by the experts.

Use of mango tree wood for entire boat and in combination of *undal* tree wood has been rated low on scientific value and efficacy. The high rating on availability of material and cost effectiveness by the experts confirms the abundance of mango tree wood and *undal* tree wood in the locality of Sindhudurg district. Experts have rated this ITK low on environmental soundness perhaps due to the fact that it might be responsible for deforestation involving mango trees.

5.3.2 Assessment of ITK on maintenance of fishing crafts.

- (a) Most of the experts have judged the ITK- use of *chandrus* mixed with groundnut oil/cashew oil/*undal* oil for maintenance of wooden crafts high on availability of material and ease in practicing. The *chandrus* and above oils are available easily in the localities of both the districts and used traditionally to minimize the wear and tear of the wooden crafts. The treatment was also considered efficient and having scientific value as most of the resins are good adhesives.
- (b) While the ITK-use of *chandrus* + oil + lime to fix the small leaks as been invariably rated high on all criteria especially with reference to its efficiency. This proves that lime, which is well known for its cementing properties in combination of oil and resin, forms a powerful adhesive.

5.3.3 Assessment of ITK on use of cotton to fabricate long line ropes.

The experts have judged this ITK high on availability of material and cost effectiveness. This confirms the consideration of fishers in choosing cotton ropes for fabrication of the ropes. As it is made of cotton and subjected to fast wear and tear in marine environment it is rated poor in terms of efficacy and scientific value by the experts. Experts might have overlooked the efficiency of the cotton ropes in terms of its easy sinking and subsequently fast paying as perceived by the fishers.

5.3.4 Assessment of ITK on tanning of cotton ropes by soaking in 'ain' tree bark solution.

Fishers carried out this treatment to minimize the wear and tear of the gear due to its constant subjection to marine environment. Experts have rated this treatment high on almost all aspects thus favoring the treatment followed by the fishers.

5.3.5 Assessment of ITK on use of plastic drums/cans for bag net and pangara tree wood plates for shore-seine.

The experts rated this ITK high on availability of material and cost effectiveness, which forms the main reasons to choose these materials as floats by the fishers. It has been rated moderate on scientific value and efficacy. This is true as far as these materials cater the function of the floats.

This ITK was rated low on environmental soundness and cultural appropriateness perhaps as plastic forms an environmental concern.

5.3.6 Assessment of ITK on use of cement rings as sinkers for gill-nets and stones, iron chain and iron rings for dol net

Experts have rated this ITK high on scientific value, availability of material, cost effectiveness, efficacy and ease in following. This is also in line

with considerations of fishers as most of these materials serve the function of the sinkers very well.

5.3.7 Assessment of ITKs on mesh sizes of major fishing gears.

The mesh sizes of almost all fishing gears meant for different fish resources are rated high on scientific value and efficacy by the fishers. This confirms the fishers' perception of choice of mesh sizes for different gears based on many factors and trial and method over the generations.

5.3.8 Assessment of ITKs on depths of operation of major fishing gears

The experts have similarly judged this ITK as above wherein they have rated the ITK high on scientific value and efficacy except for the traditional trawl. This confirms that fishers operate their nets in depths where fish resources are available.

5.3.9 Assessment of ITKs on preference time for operation of major gears

This ITK has been rated high on scientific value and efficacy by the experts except in case of time preferred for the operation of the traditional trawl. The fishers have over a long time by trial and error have choose to fish at a time which have benefited them in terms of catch and marketing. The assessment of the experts confirms the same.

5.3.10 Assessment of ITKs on specific location preferences for operation of major fishing gears.

The ITK- specific location preferences for operation of major fishing gears have been rated high on scientific value and efficacy. It might be concluded that experts considered that fishers over the years have developed- the type of fishing gear efficient in specific location with respect to nature of seabed, continental shelf and other physical characteristics influencing the presence of fish resources to ensure success.

But at the same time they have rated it low on cost effectiveness, ease in practicing and cultural soundness.

5.3.11 Assessment of ITK on use of bamboo cane basket for fish storing.

Experts have expectedly rated the ITK high on availability of material and cost effectiveness and low on scientific value, efficacy and environmental soundness. Fishers have invariably used bamboo baskets for fish storage mainly due to its cost factor and easy availability. But its efficacy is hampered as far its durability and contamination of fish is concerned.

5.3.12 Assessment of ITK on use of *boskul*, a wooden cane basket used for live storage of crabs/lobsters.

Boskul a roughly conical shaped wooden cane basket is used by the fisher to store the crabs/lobsters temporarily till it is marketed. Experts have rated this ITK high on scientific value, efficacy, cost effectiveness, availability of material and ease in practicing. This is true in the sense that due to its shape and piece of net acting as lid its top the escape of the crabs/lobsters is prevented. Experts have rated this ITK moderately on cultural appropriateness and environmental soundness. This may be because it cannot be introduced in locations where crabs and lobsters are not fished. Also it might raise environmental concern with respect to cutting of bamboos for the purpose.

5.3.13(a) Assessment of ITK on fish preservation by sun drying on cemented ground, beaches, bamboo platforms and coir mattress

Experts have rated this ITK high in cost effectiveness. It has been rated moderately on scientific value, efficacy, cultural appropriateness and environmental soundness. It has been rated high with respect to ease in practicing. The assessment of the experts is true in the sense that sun drying is very cost effective. It is efficient like India and culturally appropriate in tropical country.

5.3.13(b) Assessment of ITK on fish preservation by salting and then sun drying

Experts have rated this ITK high on scientific value, efficacy, cost effectiveness, availability of material, ease in following and cultural appropriateness. Fishers are aware that salting the fish prior to sun drying increases the efficiency of drying a view confirmed by the experts in their assessment. The practice is also cost effective, easy to follow and culturally appropriate as the price of the salt is very less, treatment is easy and is practiced all over the Indian coast.

5.3.13(c) Assessment of ITK-fish dried during winter is of good quality than dried during summer.

Experts have rated this ITK high on scientific value, as the there are less chances of microbial attack in winter due to low temperature. But at the same time they have rated it low on efficacy, cost effectiveness., ease in following , cultural appropriateness and environmental soundness. Less temperature hampers the drying and bulk of fish cannot be dried within short time.

5.3.14 Assessment of ITK-effect of wind direction- winds blowing from northerly direction fetch more catch, while those blowing from southerly direction bring less catch.

Experts have rated this ITK moderately on efficacy and low on scientific value, ease in following and cultural appropriateness. Effects of wind direction on availability on fish are usually confined to a local area and its influence as such cannot be generalized. This contradicts the trend observed by majority of the fishers.

5.3.15 Assessment of ITK on effect of water colour on fish catch-muddy water fetches more catch while clear water yields less catch.

Experts have judged this ITK high on scientific value and low on efficacy and ease in following. This is true in the sense that fish catch is related to the availability of fish food organisms and these are found abundantly in the muddy water while the clear water lacks any fish food organisms thereby yielding less catch. This view is shared by fishers as well as experts.

5.3.16 Assessment of ITKs on effect of tides on fish catch.

Experts have rated the ITK- high tide yields more catch to dol net high on scientific value, moderately on efficacy and low on cultural appropriateness and ease in following. This may be true in the sense that fishers perceive that faster currents during high tide bring more fish into the net. This is confirmed by the experts' assessment. But it may not be always efficient as there is no much difference in water force between high tide and low tide during neap tides. The ITK-high tide results in less catch to long line and traditional trawl are rated low on scientific value and efficacy contradicting the observation by the fishers. Experts have rated the ITK-transition period between the tides yield more catch to gill-net moderately on scientific value but low on efficacy, ease in following and cultural appropriateness. This assessment reflects that gill-net are always operated during the transition period and more catch observed by the fishers might have coincided with catch during transition phase. While the experts have rated the ITK-low tide yields more catch to shore-seine, provides more space for operation and facilitates hauling moderately on scientific value and low on efficacy and ease in practicing. This contradicts the perception of fishers that while hauling the net during low tide fish shoal concentrates at the center of the net and due to receding water more space is available for operation.

5.3.17 Assessment of ITKs on effect of lunar cycle on fish catch.

Experts have rated the ITK – the period between 12th day to 3rd day of lunar cycle fetches more catch to dol net, the catch is moderate during 9th day to 11th day and less during 4th day to 8th day high on scientific value but low on efficacy and ease in following. The assessment can be attributed as perceived by the fishers to the fact dol net fishery is based exclusively on the use of the tidal energy, which in turn is influenced mainly by the lunar cycle.

The ITK – the period between 4th day to 11th day of lunar cycle yields more catch to long line is rated high on scientific value and low in ease in following by the experts. Here also the view is commonly shared by the experts as well as fishers who observed that during the above period there is no much force to the water to hamper the fish movement and disturb the bait.

Experts have judged the ITK- new moon day and full moon day yield less catch to gill-nets low on scientific value, efficacy and ease in following thereby contradicting the observations made by the fishers.

5.3.18 Assessment of ITKs on indicators of cyclone

Experts have rated ITKs on indicators of cyclone such as winds gushing from south direction, exceptionally calm seawater, increase in turbidity of near shore water and accumulation of black clouds at horizon high on scientific value with moderate efficacy. While experts have rated the ITK – increase in intensity of currents as indicator of cyclone moderately on scientific value with low efficacy. Actually these are the phenomenon associated with onset of southwest monsoon and this view is expressed by the experts' assessment. Fishers didn't have any rationale regarding this matter.

5.3.19 Assessment of ITKs on behavior of fish/other aquatic organisms before, after or during the cyclone or storm.

The ITK on disappearance of fish during storm is rated high on scientific value and low in efficacy by the experts. Experts might have

concluded that some internal factors generated during storm might affect the movements of fish. But these are hypothetical assessments and the effects are very localized. Establishing rationality of such behavior requires detailed study by the workers. While the ITK- exceptionally less or more catch during or after storm is rated moderately on scientific value and low in efficacy. While the ITK on curling and coming to the surface of *Mharuche*, a type of sea snake is rated low on scientific value as well as efficacy.

5.4 Marketing pattern followed by respondents.

The discussion on marketing behavior of the fishers is given in the order of the results described earlier. Majority of the respondents auctioned their catch through middlemen. Some fishers sold dried fish to the traders. While higher than one-fifth and one-fifth fishers sold fish to agents and auctioned the catch themselves in market/shore respectively. Very few preferred to auction the catch through the co-operative society. The fishers are obligated to the middlemen or agents by virtue of credit. The present scenario shows that the fishers share in the consumer rupee is very low due to marketing intermediaries indicating inefficient marketing system.

5.5 Constraints faced by the respondents

Majority of the fishers have expressed the depletion in fish catch over the years as the main constraint they are facing. This is due to the fact that fisheries resources are fast dwindling as a result of over exploitation of fish stocks, pollution, and inadequate managerial and conservative measures.

Exploitation of fish stocks within territorial waters meant for traditional fisheries by mechanized active gears such as purse seine and trawlers have led to low returns on fish to the fishers. Because bulk quantity of fish caught by purse seines and trawlers is supplied at lower price.

Fishers in Mumbai district have suffered due to water pollution caused by industrialization and urbanization. Fishers have also suffered due to construction of artificial structures in water hampering the currents essential for the operation of dol nets. Also there are natural problems such as damage caused to the nets due to entangling in rocks, etc.

SUMMARY AND CONCLUSIONS

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Indian fisheries sector plays an important role in the national economy. It provides protein-rich diet in the form of fish and other aquatic organisms at reasonable price to the under-nourished rural populace of the country. The sector contributes about 1.3% to the nation's Gross Domestic Product (GDP) and 4.73% to the GDP originating from agriculture. The earning from export of marine products has crossed one billion US\$. Fisheries sector, in fact, has the fastest growth rate among the primary sector. The sector has grown phenomenally over the past couple of decades. Much of the development in fisheries sector especially during recent years is due to spurt in aquaculture.

The marine landings, however, have been rather static hovering around 2.6 to 2.8 million tons against the potential of 3.9 million tons. This apart, a whole lot of problems have confronted the marine as well as inland fisheries in recent years. Problems like stagnation of marine catch, depletion of stocks, over-fishing in the near shore areas; pollution, disease outbreaks, etc. are assuming alarming proportions. All this hints an altogether different approach to fisheries development is necessary in the coming years. In this context local knowledge systems of primary stakeholders like fishermen, fisherwomen and fish farmers gain prominence over the conventional technology based knowledge system. Therefore, there is an urgent need to identify, document, validate and blend the fishers local knowledge system – popularly known as indigenous technical know-how (ITK). In realization of this need, the present study was planned and carried out with the following specific objectives

1. To study the profile characteristics of respondents.
2. To document the indigenous knowledge of coastal fisher about various aspects of fishery management.

3. To analyse the fisher's rationale behind the use of the indigenous knowledge.
4. To assess and validate the documented ITK's against various criteria.
5. To identify the constraints faced by coastal fishers with respect to fishery management.

Maharashtra state was purposively selected for the study as it is a leading maritime state and researcher hails from this state. The study was restricted to two coastal districts of Maharashtra, viz., Greater Mumbai and Sindhudurg. Five fishing villages were selected from each of these districts using random sampling procedure. Thus there were 10 study villages. A total of 100 fishers essentially practising traditional fishing methods representing these 10 study villages constituted the sample for the study.

Keeping in view the objectives of the study and qualitative nature of the data requirements thereof, exploratory survey research design was employed for the study. Accordingly, a combination of personal interview and non-participant observation methods was used for data collection. A semi-structured and pre-tested interview schedule was used for data recording in addition to researchers personal notes and other documentary evidences supporting the data. The respondents were contacted and interviewed individually either at the society, home or at the landing center. Further the ITKs documented based on the survey of fishers were assessed for their validity in terms of a set of seven criteria identified based on literature survey and dialogue with experts. For this purpose, a checklist of major documented ITKs along with the seven criteria namely scientific value/logic, efficacy, cost effectiveness, availability of materials, easy to follow, cultural appropriateness and environmental soundness was developed. This checklist was then mailed / personally handed over to 50 fishery experts comprising scientists, academicians and development personnel with a request to assess each of the documented ITKs against the listed criteria. Thirty experts responded with

complete information in the stipulated time. The data so collected were codified, tabulated and analysed using simple statistical tools of frequency and percentage. The salient results of the study are as follows:

1. Profile analysis of the respondents revealed that majority are of middle age (in the range of 30 to 50 years), literate, married, with a minimum fishing experience of 10 years, have large (> 4 members) and nuclear families and dwell in *pucca* houses.
2. Analysis of the data on ITKs pertaining to various fishery management practices revealed that:
 - i. There was lot of variation in the types of indigenous fishing crafts and gears used in the two study districts.
 - ii. Mango tree wood and teak wood are the major construction material used in Sindhudurg and Greater Mumbai districts, respectively.
 - iii. Considerable diversity in the fishing crafts in terms of their make, OAL, width, depth, fish hold capacity and crew number was observed in the two districts.
 - iv. Treatment with an indigenous mixture of *chandrus* – a type of resin – and oil such as ground nut oil / linseed oil / *undal* tree oil / cashew oil is the popular ITK for maintenance of fishing crafts.
 - v. Gill net is the major fishing gear used in the study area.
 - vi. District-wise comparison of fishing gears revealed that gill-net and rampani were the major gears in Sindhudurg while bag-net and gill net were the important ones in Greater Mumbai.
 - vii. Bulk of the fishing nets in the area are fabricated using nylon-based material. Very few fishers (07.00 %) used indigenous material in the form of cotton for the purpose.

- viii. Wide variation was noticed in the gear dimensions such as mesh size, depth and time of their operation.
- ix. Tanning of cotton ropes by soaking them in a solution of *ain* (*Pterocarpus hirsuta*) tree bark was an important ITK on maintenance of gears.
- x. Majority of the fishers used conventional floats readily available in the market for different gears.
- xi. Plastic drums or cans and *pangara* (*Erythina indica*) tree wood plates are the important indigenous floats used for bag-net and shore-seine, respectively.
- xii. Diverse indigenous materials were used as sinkers depending on the type of gear operated.
- xiii. Less than one-third (32.00%) respondents used conventional sinkers. Stones (35.00%), iron chains (17.00%) and cement rings (10.00%) were the important indigenous sinkers used in the area.
- xiv. Nine out of every ten (90.00%) fishers used bamboo cane baskets for fish storage. A modified version of the bamboo cane basket known locally as *boskul* and wooden box insulated with thermocol were the other structures used for the purpose.
- xv. Fish preservation of any kind was followed by less than half (41.00%) of the respondents. Sun drying was the most common indigenous method of fish preservation. Few fishers also practiced salting followed by sun drying.
- xvi. With respect to ITK on effect of wind direction on fish catch, all but three respondent fishers (97.00%) opined that winds blowing

from north direction fetch more catch while southward winds lead to less catch.

- xvii. Fishers have definite perception of water colour as indicator of fish availability. Majority (82.00%) believed that muddy water indicates more catch while three quarter (75.00%) of them felt clear water indicates poor catch prospects.
- xviii. Fishers have their own logic in assessing the suitability of different fishing methods as per the tidal fluctuations. Great diversity was noticed with respect to the perception of fishers about the effect of tides on fish catch to different gears.
- xix. All the respondents expressed that low tide fetches more catch to shore-seine and during high tide more effort is required to haul the traditional trawl.
- xx. Seven out of every ten respondents felt that high tide is good for dol-net as it fetches more catch but not suited for long line operation as it may not yield good catch.
- xxi. Around two-third (65.00%) respondents revealed that transition period between high and low tides fetches more catch to gill-net.
- xxii. All the respondents perceived that the periods of 12th day to 3rd day and 4th day to 11th day of lunar cycle are good for obtaining more catch while the period between 4th day to 8th day brings very less catch. They also experienced moderate catch during 9th to 11th day of lunar cycle. Majority of them (84.00%) realized less catch on Full Moon Day and New Moon Day.
- xxiii. Fishers perception exhibited a lot of variation regarding the of indicators of cyclone and storms. The important indicators as per majority opinion were sudden increase in the intensity of water current, winds gushing from south direction, sea water remains

exceptionally calm, black clouds are seen at the horizon, near-shore water slowly starts getting turbid and mud gets in to net in the form of flat nodules.

xxiv. Majority of the fishers studied had less idea of the behaviour of fish and other aquatic organisms before, during or after cyclone/ storm. Very few of them revealed curling and coming to surface of a type of sea snake *Mharuche* and disappearance of fish as indicators of cyclone and storm.

xxv. A large majority (84.00%) reported that they observe closed season for fishing.

3. Analysis of the data on assessment of documented ITKs revealed that

- i. Use of teakwood alone for the entire boat was rated high on scientific value / logic and efficacy, but low on other criteria like availability of material, easy to follow, cultural appropriateness and environmental soundness.
- ii. Use of teakwood in combination with babul tree wood for the purpose was rated high on efficiency, cost effectiveness, availability of material; moderately on scientific value / logic and easy to follow, and low on environmental soundness and cultural appropriateness.
- iii. Uses of mango tree wood alone for the entire boat and in combination with undal tree wood though assessed high on availability of material and cost effectiveness were rated low on other criteria.
- iv. Use of chandrus mixed with oil (groundnut oil / cashew oil / undal oil) for maintenance of boats was rated high on availability of material and moderate on all other criteria.

- v. Use of a mixture of chandrus, oil and lime to fix the leakages in boat was assessed high on efficacy and moderate on other assessment criteria.
- vi. Use of cotton, as an indigenous material for net fabrication was rated moderate on all but efficacy criteria on which it was assessed low.
- vii. Tanning of cotton ropes by soaking in solution of 'ain' (*Pterocarpus hirsuta*) tree bark for maintenance was rated high on availability of material and environmental soundness, and moderate on the remaining five assessment criteria.
- viii. Use of plastic drums / cans for bag-net and *pangara* (*Erythina indica*) wood plates for shore-seine as indigenous floats was rated high on cost effectiveness and availability of material; moderate on easy to follow, scientific value / logic and efficacy, and low on cultural appropriateness and environmental soundness.
- ix. Use of indigenous sinkers like cement rings for gill-nets and stones, iron chains and iron rings for dol-net was rated high on scientific value / logic, availability of material, cost effectiveness, efficacy, easy to follow and moderately on the other two criteria.
- x. Experts restricted the rating of the different mesh sizes of all the major fishing gears to two criteria namely scientific value / logic and efficacy. Accordingly all the mesh sizes were rated moderate to high.
- xi. Different depths of operation recorded for different nets were rated high on most of the criteria.

- xii. Times of operation of different nets were assessed moderate to high on scientific value / logic and efficacy, and low on easy to follow and cultural appropriateness.
- xiii. Operation of shore-seine along stretches of sandy beaches was rated high on scientific value / logic and efficacy, and low on cost effectiveness, easy to follow and cultural appropriateness.
- xiv. Operation of spike dol-net in waters with high current force was rated high on scientific value / logic; moderate on efficacy and low on cost effectiveness, easy to follow and cultural appropriateness.
- xv. Operation of anchor dol-net relatively low current force waters was rated moderate on scientific value / logic and efficacy, and low on cost effectiveness, easy to follow and cultural appropriateness.
- xvi. Use of bamboo cane basket as indigenous structure for fish storage was assessed high on cost effectiveness; moderate on availability of material, easy to follow and cultural appropriateness, and low on scientific value / logic, efficacy and environmental soundness.
- xvii. Use of *boskul*, a wooden cane basket as indigenous structure for live storage of crabs and lobsters was rated moderate on all criteria but environmental soundness on which it was assessed low.
- xviii. Fish preservation by sun drying on cement ground / beaches / bamboo platform / coir mattress was assessed high on cost effectiveness and easy to follow; moderate on scientific value / logic, efficacy, availability of material and cultural appropriateness, and low on environmental soundness.

- xix. Fish preservation by salting followed by sun drying was assessed high on scientific value / logic, efficacy, cost effectiveness and easy to follow; moderate on availability of material, cultural appropriateness and environmental soundness.
- xx. The ITK 'fish dried during winter is of good quality than that dried during summer' was rated high on scientific value / logic and low on efficacy, cost effectiveness, easy to follow, cultural appropriateness and environmental soundness.
- xxi. The ITK 'winds blowing from northerly direction fetch more fish catch while winds blowing from southerly direction bring low catch' was rated moderate on efficacy and low on scientific value, easy to follow and cultural appropriateness.
- xxii. The ITK 'muddy water fetches more catch while clear water yields less catch' was rated high on scientific value but low on efficacy and easy to follow.
- xxiii. Among the four major ITKs pertaining to effect of tides on fish catch, only one namely high tide yields more catch to dol-net was rated high on scientific value / logic.
- xxiv. The ITK 'period between 12th day to 3rd day of lunar cycle fetches more catch to dol net, the catch is moderate and less during the period 9th day to 11th day and 4th day to 8th day, respectively' was rated high on scientific value / logic and low on efficacy and easy to follow.
- xxv. The ITK 'period between 4th day to 11th day of lunar cycle yields more catch to long line' was rated moderate on scientific value / logic and efficacy, and low on easy to follow.

xxvi. The ITK 'New Moon Day and Full Moon Day yield less catch to gill-nets found low rating in terms of scientific value, efficacy and easy to follow.

xxvii. All the indigenous indicators of occurrence of cyclone and storm were rated to have scientific value / logic by majority of the experts.

xxviii. The ITKs on behaviour of fish and other aquatic organisms before, during or after cyclone were rated moderate to low on scientific value / logic and efficacy.

4. With respect to marketing patterns followed by fishers, it was observed that they sell part of the catch immediately and remaining they process and sell later. Auction through agent / middlemen, sale of died fish to traders and sale to agents were the major marketing practices noticed.
5. About two-thirds (64.00%) of the fishers expressed 'depletion of catch' as a pressing constraint.

Policy implications and recommendations

Traditional and artisanal fishing practices have their own importance in sustaining the marine fish production on one hand and environmental conservation on the other. These can play a significant and complementary role with the modern science and technology backed fishing practices. Therefore, a judicious blend of indigenous and modern practices is the need of hour in Indian fisheries development. Towards this end, the study has come out with several crucial observations and findings having far reaching recommendations and policy interventions. On the basis of the salient findings of the study, the following measures are suggested as policy implications and recommendations

1. The study has documented rich, varied and potential ITKs on fishery management. The validity of a few ITKs on fishery management has also been established by the study. Efforts are, therefore, stressed for thorough scientific study of such ITKs in order to refine and disseminate the same for large-scale adoption by fishers.
2. Many of the ITK documented are based on local convictions rather than any scientific logic. Those ITKs that were assessed low on environmental soundness e.g. use of mango tree wood as construction material for fishing crafts, call for immediate efforts by the developmental agencies to educate the fishers on the importance of environmental conservation. Scientists should make efforts to either replace such practices by environmentally sound options or to refine the ITKs to make them environmentally safe.
3. Systematic appraisal of the indigenous knowledge systems by a multi-disciplinary team of fishery experts should form a key element in the integrated coastal zone management strategies.
4. Location specific, adaptive and fisher participatory research would go a long way in identifying, nurturing, refining and field testing of indigenous knowledge systems of fishery management for their appropriateness in the socio-cultural and economic domains.

Suggested lines for further research on ITKs on fishery management

1. The present study was finally restricted to only two coastal districts of Maharashtra due to limited time and resource availability. A comprehensive study may be carried out to extensively document the ITKs for the entire coastal region of the country. The database so evolved would be of great importance for local planning of fisheries R&D.
2. ITK studies may be extended to cover the inland fishery regimes as well.

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APPENDICES

APPENDIX-I
INTERVIEW SCHEDULE
PART A

1. Profile of the respondent

a. Name and address of the respondent

b. Age

c. Marital status M/U

d. Educational status illiterate/ read only/ read and write/ primary
school/ highschool/ college

2. Occupation

a. Main

b. Subsidiary

3. Number of family members small(less than 4)/large(more than 4)

4. Type of family Nuclear/joint

5. Type of house RCC/ PUCCA/ THATCHED HUT

PART B

INDIGENOUS TECHNICAL KNOWLEDGE IN FISHERIES

A. INFORMATION TO BE GATHERED ABOUT BOAT

1. Type of boat owned and how long

NAME	MOTORIZED/NON-MOTORISED

a. If motorized, engine make and horsepower

b. Equipment used onboard

2. Details of boat

a. Material used for boat construction. Why?

TYPE OF WOOD	USED WHERE	REASON

b. Dimensions of boat and reasons

	Boat1	Boat 2	Reasons
OAL			
BEAM WIDTH			
DEPTH/HEIGHT			

c. Number of crew

No.	Age	Sex

d. Fish hold capacity

e. Depth of operation

3. Why do you prefer this type of boat?
4. What are methods adopted for its maintenance?
5. Why do you use particular oil or lubricant?
6. Why do use particular paint?
7. What treatment you do for protection of boat?
8. Why and how this treatment is carried out?
9. Cost incurred per treatment and interval of application.
10. Are you aware of modern trends in installation of new fish finding devices? Y/N
11. If yes who made you aware?
12. If no are satisfied with this type of boat and why?

B. INFORMATION TO BE GATHERED ABOUT GEARS

1. Type of the gear used and how long?
2. Selective/ non-selective

3. Name of the net
4. Material used for its fabrication and why?
5. Parts of net
 - a. Specifications- Length/ breadth/ height
 - b. Mesh size
6. Type of floats used and why?
7. Type of sinkers used and why?
8. Type of colouration used and why?
9. What methods you adopt for prevention of wear and tear of the gear and why?
 - a. Material used
 - b. Purpose of use

C. INFORMATION ABOUT FISH PRESERVATION AND PROCESSING.

1. Method of fish preservation adopted- specify
2. Why the particular method is adopted
3. Who taught you this method?

4. What indigenous method you adopt for processing of fish?

5. Whether any byproducts are prepared? How?

6. For what purpose the by-products are used?

D. METHODS OF FISH STORAGE

1. Fresh

2. Processed fish

E. METHODS OF FISH PACKING

1. Fresh fish

3. Processed fish

F. PREFERENCE TIME AND FISHING GROUND

1. Whether the fishing is carried out during specific time in a day and why?

2. Whether the fishing is carried out in particular location/ fishing ground?

3. How do you know the resource availability in particular location?

G. INFORMATION ABOUT WIND

1. What is the significance of wind direction on availability of fish?

DIRECTION	FISH SPECIES AVAILABLE	REASONS
EAST		
WEST		
NORTH		
SOUTH		
SOUTHWEST		
NORTHWEST		
SOUTHEAST		
NORTHEAST		

H. EFFECT OF TIDES

1. How do you foresee the exact time of occurrence of tides?

a. High tide

b. Low tide

J. WATER COLOUR AND AVAILABILITY OF FISH.

1. What is the significance of water colour in getting the particular fish catch/shoal?

COLOUR	PARTICULAR CATCH	RATIONALITY
BROWN		
GREEN		
BLUISH		
MUDDY		
CLEAR		

K. INFORMATION ABOUT LUNAR CYCLE.

1. What is the effect of lunar cycle on fish catch or fishing? Why?

L. OBSERVANCE OF CLOSED SEASON

1. Don you observe closed season? Why?
2. What is the extent of closed season?
3. When do you restart fishing? Why?

M. MEANS OF MARKETING

1. Whether the fish is sold in the market or consumed by you?

2. Fresh fish marketing.
3. Processed fish marketing.
4. Why the particular method is adopted?
5. Marketing channels.

N. CONSTRAINTS FACED.

- a. Social stigma/ Storm/ disease/ none
- b. Depletion of catch.
- c. Marketing: Low cost/ middlemen intervention/ inadequate extension service

APPENDIX II

Central Institute of Fisheries Education
(Deemed University)
Indian Council of Agricultural Research.

Dr. R. S. Biradar,

Principal scientist and Head,
Fisheries Informatics and Technology Transfer Division,
CIFE, Mumbai-400 061

Dear Sir,

Mr. Vivek Nirmale a Ph. D. student of this deemed university has taken up a research study "**Indigenous Knowledge in Management ^{cf} marine Fisheries of Maharashtra**" as a part of his doctoral research work under my guidance. The study aims at documenting and validating the indigenous technical know-how of coastal fishers of Maharashtra. To this end he has identified 18 indigenous practices/indigenous technical know-how's followed by coastal fishers of Mumbai and Sindhudurg districts. The identified ITK's are listed in Appendix III and the same are to be validated. In view of your academic qualifications and rich experience in the area of coastal/marine fisheries management your expert opinion is sought in validating the ITK's identified. For this purpose certain criteria have been identified based on survey of literature. You are requested to kindly spare some of your valuable time to evaluate each of the ITK against the criteria listed and indicate your judgement by either a ✓ (representing agreement) or × (disagreement) with reference to each criterion.

I once again request you to give your valuable inputs and enable Mr. Nirmale in timely completion of his research work. An early reply is appreciated.

Thanking you

With regards

yours faithfully,

(R. S. Biradar)

8	Depth of operation									
a	Trammel net									
b	Mackerel gill net									
c	Seerfish gill net									
d	Drift gill net									
e	Bottom gill net									
f	Dol net									
g	Long line									
h	Rampani									
i	Traditional trawl									
9	Preference time for fishing									
a	Trammel net									
b	Mackerel gill net									
c	Seerfish gill net									
d	Drift gill net									
e	Bottom gill net									
f	Dol net									
g	Rampani									
h	Long line									
ii	Traditional trawl									
10	Location specific operation of nets									
a	Operation of shore seine along the stretches of wide sandy beaches									
b	Operation of spike dol net in waters where current force is more									
c	Operation of anchor dol net in water force is relatively less.									
11	Fish storage									
a	Use of bamboo basket for fish storing									
b	Use of <i>boskul</i> a bamboo cane basket for live storage of crabs/lobsters. The basket is roughly conical, covered with a piece of net and kept submerged in water nearshore.									

12	<p>Fish preservation Sundrying on cemented ground, beach, bamboo platform or coir mattress Salting and then Sundrying Fish dried during winter is good quality than summer</p>								
a									
b									
c									
13	<p>Effect of wind direction Winds blowing from northerly direction fetch more catch, while winds blowing from southerly direction brings less catch</p>								
14	<p>Water colour and fish availability Muddy water yields more catch while clear water yields less catch</p>								
15	<p>Effect of tides High tide yields more catch to dol net. High tide results in less catch to long line. Transition period between 2 tides yields more catch to gill nets. Low tide yields more catch to shore seine, provides more space for operation and facilitates hauling.</p>								
a									
b									
c									
d									
16	<p>Effect of lunar cycle Period between 12th day to 3rd day of lunar cycle fetches more catch to dol net, the catch is moderate and less during the period 9th day to 11th day of lunar cycle and 4th day to 8th day respectively. The period between 4th day to 11th day of lunar cycle yields more catch to long line. New moon day and full moon day yield less catch to gill nets.</p>								
a									
b									
c									
17	<p>Indicators of cyclone Increase in intensity of currents Winds gushing from south direction Exceptionally calm seawater Increase in turbidity of nearshore water Accumulation of black clouds at horizon. Occurrence of mud into net in form of flat nodules.</p>								
a									
b									
c									
d									
e									
f									

18	<p>Behavior of fish/other aquatic organisms before, during or after storm/cyclone</p> <p>Curling and coming to sea surface of <i>Mharuche</i> a type of sea snake.</p> <p>Disappearance of fish.</p> <p>Transverse swimming of black pomfret or tilting behavior.</p> <p>Exceptionally less or fish catch.</p>								
a									
b									
c									
d									