2.1 Introduction

Knowledge has an endless growth. It is constantly growing. A thorough awareness of the various ways in which subjects originate and develop and also the structure they assume is a prerequisite for designing classification of knowledge. Therefore the function of the information scientist to explore into the structure and growth of subjects and to design system for an effective storage and quick retrieval of information is gaining relevance and gathering momentum. The research team at Documentation Research and Training Centre, Bangalore has developed a methodology to study the structure and development of subjects, and using this methodology, the subject Fishery science is analysed as given below.

2.2 Outline of the Subject

Fishes are cold blooded animals typically with backbones, gills and fins and are primarily dependent on water as a medium to live in. The study of fish and its natural history is known as 'Ichthyology'. By the development of marine biology and industrialisation, studies relating to fishes also expanded from natu...
history to methods of fishing, stock, culture etc. Thus the science of study of fishes developed into Fishery science and is recognized as a multidisciplinary field under Zoology.

As the trend to develop fisheries is increasing all over the world, Fishery science has become an important field of research. To improve fisheries, the support of scientists and technologists is important. The improvement will depend on quality of research and development undergoing in research organizations throughout the world.

2.3 **Definitional Analysis**

A comprehensive and well accepted definition for Fishery science is not available as it is an emerging subject area. Earlier concept of Ichthyology from which Fishery science has developed, is defined in popular dictionaries, encyclopaedia and handbooks. Some of them are given below.

2.3.1 **Dictionaries**


Ichthyology - A branch of vertebrate zoology that deals with the study of fishes.

Ichthyology — The study of fishes.

Fish — Animal living exclusively in water (strictly) one class of vertebrate aquatic animals having gills throughout life and usually fins.

2.3.2 Encyclopaedia


Ichthyology — the study of fishes.

Fish (usage) — Although plural of fish is fishes. The singular term has been accepted to mean all fish.

2.3.2.2 Encyclopaedia Americana, American Corporation, New York, 1973.

Ichthyology is a branch of Zoology that is concerned with fishes, their structure, classification, ecology and distribution.

Fish — An aquatic vertebrate (backboned) animal that typically breathes by means of gills and moves by means of fins.
Ichthyology - Scientific study of fishes, including, as is usual with a science that is concerned with large groups of organisms, a number of specialised subdisciplines eg. taxonomy, ethology, ecology and physiology.

Fishes - The term fish is applied to a variety of cold blooded aquatic vertebrates of several evolutionary lines. It describes a life form rather than taxonomic group.

Ichthyology - the study of fishes a branch of natural history.

Fish - are backboned animals which breathe through gills and have fins.

Handbooks or Textbooks

Jhingran, V.G. Fish and Fisheries of India Ed.3
Hindustan Publishing Corporation (India), Delhi, 1991.

Fishes - are cold blooded aquatic vertebrates which breathe by means of pharyngeal gills, propelling and balancing themselves by means of fins.
Fishery Science is the scientific study of the use of living resources of the waters. Part of fishery science is concerned with biological, physical and chemical aspects of the process of organic production.

Ichthyology is the study of fish - pure and applied aspects of science of ichthyology.

Fish - Fishes are cold blooded animals typically with backbones, gills and fins and are primarily dependent on water as a medium in which to live in.

Ichthyology - the study of fishes is dealt with under heads - taxonomy, morphology, embryology, ecology, histology, physiology, endocrinology etc.

Fish - is a cold blooded vertebrate adapted to aquatic mode of life.

2.3.3.2 Lagler, K.F. Ichthyology Ed.2 John Wiley & Sons, New York, 1977.

Ichthyology - The study of fish - pure and applied aspects of science of ichthyology.

Fish - Fishes are cold blooded animals typically with backbones, gills and fins and are primarily dependent on water as a medium in which to live in.

2.3.3.3 Sharma, V and Grover, S.P. An introduction to Indian Fisheries. Bishen Singh Mahendrapal Singh, Dehra Dun, 1982.

Ichthyology - the study of fishes is dealt with under heads - taxonomy, morphology, embryology, ecology, histology, physiology, endocrinology etc.

Fish - is a cold blooded vertebrate adapted to aquatic mode of life.


Fishery Science - Fishery Science is the scientific study of the use of living resources of the waters. Part of fishery science is concerned with biological, physical and chemical aspects of the process of organic production;
part with the distribution and abundance of resources; part with the effects of fishing. It is an applied science including study directed at basic understanding as well as study designed to provide a background for decisions.

2.3.4 **Consolidated Definition**

Most of the aforesaid definitions of 'Ichthyology' are primarily concerned with identification and nomenclature of fishes. No publication even the world famous encyclopaedias or technical terms dictionary try to update the definition according to recent developments. Royce (2.3.3.4) gives an advanced definition which can be taken as the consolidated definition. Thus Fishery science in the broad sense is the study of exploited aquatic animal resources for the purpose of generating an increased benefit to man.

2.4 **Terminological Development**

According to Norman [1] the term fish originated from the Greek word 'Ichthys' meaning Jesus Christ, son of God, saviour. Fish was an early christian symbol adopted sometime in the second century A.D. In 'Bhagavata Purana', Matsya Avatar the fish incarnation of Vishnu whose function was to save mankind is described. It is known that about 71% of earth's surface is covered by water. Fish is a vital food all over the world and it
provides employment and export earnings to many. Fishing is one of the oldest employments. Primitive methods of fishing were reported from China and Japan. Fishing is also linked with water transport. Earlier raft and canoes used for fishing were used for transport also.

Fishes were in existence from about 5 million years ago. Aristotle is said to be the founder of Ichthyology according to early history of fishes. In his work "Historia animalium" a large portion deals with fish. Early Ichthyologists concentrated mostly on systematics and natural history of fishes. The applied aspects of fishery science developed later in 19th century. Fishery science, which comprises study of fishes and other commercially important aquatic organisms, developed recently, has two roots—in the development of marine biology and in the industrialization of fisheries' [2]. Development in marine biology started by the expeditions began with the survey voyages of James Cook. The science of oceanography started with the Challenger Expedition in 1872. The collections made by the expeditions were at first examined in Universities. Later, separate Marine Laboratories were established. When decrease in yield occurred after industrialization of fishery, scientific advice was needed to explore new fishing grounds and to investigate reasons for change in catches. By the worldwide expansion of fisheries research a number of organizations were formed in many parts of the world.
especially under Food and Agriculture Organisation (FAO). Developments such as Laws of the Sea Conference which enforced Exclusive Economic Zone (EEZ) for coastal states also influenced fishery science studies. More international collaboration on research contributed to the development of aquaculture, environmental studies, fisheries management etc. Fisheries administrators and managers are relying more on advice from scientific researchers. This enhances the development of Fishery science.

Earlier developments in fish science and technology took place in many European countries due to fishery exhibitions which created an awareness in the minds of the public. By the beginning of 20th century, there developed a relation between applied science and industries. Fishery science research also became more applied with special concern for problems of fishermen. The term fishery science became popular and established in the place of ichthyology.

2.5 Scope of the subject

The study of aquatic sciences is divided mainly into marine and freshwater sciences which are collectively called 'Oceanography' and 'Limnology' respectively. These studies are of importance to Fishery science which is an applied science. Oceanography and Marine biology
studies such as hydrology, planktonology, productivity etc help to understand the reasons for fluctuations in fish landings. Similar to aquatic science, fishery science is divided into marine fisheries and fresh water fisheries (inland) based on the type of water. A third division, brackish-water fisheries which belongs to either fresh or marine origin is also described [3]. Fishery science has thus developed all over the world based on these strong foundation of the aforesaid branches of aquatic sciences.

2.5.1 **Divisions and subdivisions**

2.5.1.1 **Freshwater fisheries (Inland)**

Freshwater includes rivers, reservoirs, lakes, tanks and ponds. Studies show that world’s freshwater resources are mainly from Asian countries such as China, India etc. Freshwater fisheries depend on ecological features such as Physico-chemical and hydrobiological conditions. Recently research on unexploited brackish water areas such as mangroves is also being conducted extensively.

2.5.1.2 **Marine fisheries**

Marine fisheries all over the world include studies on resources from oceans namely Atlantic, Pacific, Indian and the adjacent seas. Developments in Marine fisheries also show an increasing trend all over the world.
Both freshwater and marine fisheries are further divided based on the distribution. Thus there is the pelagic fishes which belong to the upper part of the water and demersal which belong to bottom part. Two divisions of fisheries commonly referred to in research organisations are capture and culture fisheries.

International Standard Statistical Classification on Aquatic Animals and Plants (ISSCAAP) divides commercially important aquatic species as follows [4]. Food fishes such as some crustaceans and molluscs, are also grouped under fishes.

<table>
<thead>
<tr>
<th>Code</th>
<th>Division</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>FRESHWATER FISHES.</td>
</tr>
<tr>
<td>11.</td>
<td>Carps, barbels and other cyprinids.</td>
</tr>
<tr>
<td>12.</td>
<td>Tilapia and other cichlids.</td>
</tr>
<tr>
<td>2.</td>
<td>DIADROMOUS FISHES.</td>
</tr>
<tr>
<td>21.</td>
<td>Sturgeons, paddlefishes etc.</td>
</tr>
<tr>
<td>22.</td>
<td>River eels.</td>
</tr>
<tr>
<td>23.</td>
<td>Salmons, trouts, smelts etc.</td>
</tr>
<tr>
<td>24.</td>
<td>Shads etc.</td>
</tr>
<tr>
<td>25.</td>
<td>Miscellaneous diadromous fishes.</td>
</tr>
<tr>
<td>3.</td>
<td>MARINE FISHES.</td>
</tr>
<tr>
<td>31.</td>
<td>Flounders, halibuts soles etc.</td>
</tr>
<tr>
<td>32.</td>
<td>Cods, hakes, haddocks etc.</td>
</tr>
<tr>
<td>33.</td>
<td>Reeffishes, basses, congers etc.</td>
</tr>
</tbody>
</table>
Jacks, mullets, sauries etc.
Herrings, sardines, anchovies etc.
Tunas, bonitos, billfishes etc.
Mackerels, snooks, cutlassfishes etc.
Sharks, rays, chimaeras etc.
Miscellaneous marine fishes.

CRUSTACEANS.

Freshwater crustaceans.
Sea-spiders, crabs.
Lobsters, spiny rock-lobsters etc.
Squat lobsters.
Shrimps, prawns etc.
Krill, planktonic crustacea etc.
Miscellaneous marine crustaceans.

MOLLUSCS

Freshwater molluscs.
Abalone, wrinkles, conches etc.
Oysters.
Mussels.
Scallops, pectens etc.
Clams, cockles, arkshells etc.
Squids, cuttlefishes, octopuses.
Miscellaneous marine molluscs.

WHALES, SEALS AND OTHER AQUATIC ANIMALS.

Blue Wahles, fin whales etc.
Sperm whales, pilot whales etc.
Eared seals, hair seals, walruses etc.
64. Miscellaneous aquatic mammals

7. MISCELLANEOUS AQUATIC ANIMALS

71. Frog and other amphibians.

72. Turtles.

73. Crocodiles and alligators.

74. Sea squirts and other tunicates.

75. Horseshoe crabs and other arachnoids.

76. Sea urchins and other echinoderms.

77. Miscellaneous aquatic invertebrates.

8. MISCELLANEOUS AQUATIC ANIMAL PRODUCTS.

81. Pearl, mother-of-pearl, shells etc.

82. Corals.

83. Sponges.

9. AQUATIC PLANTS

The major divisions of fishery science where active research is going on include fishery biology, ecology, stock (management), physiology, reproduction, genetics, pathology, pollution, technology, aquaculture and marketing. They are briefly examined below.

2.5.1.3 Fishery biology

Earlier studies were mainly on systematics and taxonomy of fishes. When fish catch began to decrease other areas of the subject developed. Thus the food and feeding habits, length-weight relation and other similar biological studies were started by research workers.
These studies help in assessing the areas of fish occurrence, habitat etc.

2.5.1.4 **Fish stock management (resource assessment)**

The need to increase the fish resource led to the management of fisheries. New methods of fish stock estimation were introduced, using statistics. The establishment of Food and Agriculture Organisation led to many developments in fish stock management. FAO has a separate fisheries division which publishes data on fish landings and products from all over the world.

The increased demand for fish due to the growth of population and rise in per capita consumption has necessitated the establishment of an effective management system. Earlier, fish have been considered to belong to no one and so all waters were free and open to fishing. Later, need for authority over territorial sea was recognized and the limit of 200 mile Exclusive Economic Zone (EEZ) was set by the International Convention of Law of the Sea. Management of fisheries by laws becomes prominent when it is found that the abundant stock is reduced by overfishing.

2.5.1.5 **Fishery Ecology**

Ecology is a broad, complex and very young science which is a branch of biology with inter-relationships among organisms and with their environment. As fish
lives in water, the factors which affect it include salinity, temperature, food availability, productivity etc. Ecological studies include pattern of distribution, population dynamics, age composition interspecies relations, food chains, production efficiency etc.

2.5.1.6 Fish Physiology

Physiological aspect of various functions like growth, feeding, nutrition, behaviour etc. are important in fishery science. It is also helpful in aquaculture practices where selection of species and rearing of fish are to be done carefully.

2.5.1.7 Fish reproduction

Different reproductive processes such as maturity, fecundity, spawning and development form an important division of study. These studies help in protecting the vulnerable species, culture and predicting the fishery.

2.5.1.8 Fish genetics

With the development of fish culture, genetic studies of fish are also gaining importance. Genetic studies have enabled evolving new hybrid fishes, artificial fertilization, selecting fishes for culture, identification of population etc.
2.5.1.9 **Pollution and Fisheries**

Fishes are vitally affected by the media in which they live. The physical, chemical and biological changes in waters affect the fish population. Physical and biological aspects are studied in ecology. Due to industrialization, discharge of chemical waste into natural waters is increasing. These chemicals cause pollution which is sometimes fatal to aquatic life. Studies concerning pollution and its effect on fisheries are important for management of species.

2.5.1.10 **Fish Pathology**

Studies of disease of fish — causes and prevention form the pathology of fishes. Causes for disease vary and the kinds of diseases are many. Their prevention and control are important in increasing fish yield and in fish culture.

2.5.1.11 **Fish Technology**

Fishery technology is the application of the fish science to the industrial art of fishing, fish handling and processing. Development of fishery practices began by the mechanisation of crafts and gear. Use of electronic and other gadgets for locating fishing grounds helped to improve fisheries. For processing and handling many new mechanised methods are applied. Even the fishing vessels are having equipments for processing and
preserving fish. This division is a fast growing field with many new subdivisions such as 'industrial fisheries'.

2.5.1.12 **Aquaculture**

The controlled farming of aquatic organisms is called aquaculture. Fish farming was practised in China in 2000 B.C. Subdivisions of aquaculture can be broadly segregated by the type of water in which it is practised. Freshwater or inland aquaculture and marine or mariculture. Fresh water aquaculture includes culture of organisms both in fresh and brackishwaters. This has developed in countries with well developed freshwater resources. Mariculture or marine aquaculture originated in Indonesia around 1400 A.D. Culture of marine organisms is done generally in habitats like edge of the sea, inshore bays, covers, inlets and in floating cages or in open sea. Besides finfishes, cultivable organisms include shrimp, crab, oyster, cephalopod, sea turtle and sea cucumber. More emphasis is given in countries for culture of prawn as it is an important export item.

2.5.1.13 **Export of Aquatic Products (Marketing)**

Developments in fisheries and aquaculture has led to increase in export items such as preserved fish and prawn, fish meal, oil, pearl, coral, turtlemeat and seacucumber. Export of ornamental fishes and equipments
for aquarium also have developed as an industry. India is one of the major countries exporting marine products to many countries. The export trend shows an increase every year.

2.5.1.14 Fishery Economics

Economic problems of fisheries management and aquaculture are of recent origin. Measures for management are to be taken with due consideration for economic problems of those involved in fisheries. Similarly aquaculture practices also have to be designed with reference to economic aspects.

2.5.2 Applications

Fishery science is an applied science including basic studies as well as studies of new technological developments. After the second world war, the need for food supply increased. Thus new methods and equipments for fishing were made use of to increase the fish catch. Earlier there were no restrictions in fishing but the need to conserve the resources which showed depletion, resulted in the formulation of International Law of Fisheries at the third Conference on Law of the Sea held in Geneva in 1958. Management of fishery was done scientifically which included limiting the fishing zone for coastal states to 200 mile EEZs [7]
Aquaculture developed applying modern methods and techniques. Improved methods of culture results in increased production of cultured fishes. Fishery science helped the development of fish industry. Export of fish and other marine products increased and it has become a major income for those involved in the industry. Improved methods of processing, preserving and quality control have produced better products for export. Thus fishery science has become capable of diagnosing the state of fisheries as a 'bio-technico-economic social system' [8].

### 2.5.3 Tool Subjects

As the subject fishery science is interdisciplinary, it is a synthesis of a number of scientific disciplines, concerned with fish as food - mainly Physics, Chemistry, Statistics, Microbiology, Oceanography, Limnology, Marine biology and Economics. These subjects help in developing fishery science directly or indirectly.

Studies of oceanography and limnology are concerned with physical, chemical and biological features of oceans and freshwater which enable fishery scientist to study the factors affecting the production of fishes. Similarly marine and freshwater biology deal with structure, physiology, behaviour etc of aquatic fauna and flora, which help fishery scientists to identify and understand the relationship among aquatic organisms.
Application of Physics and Chemistry is useful in the physical and chemical properties of the environment and fish processing techniques. Microbiology is applied in quality control studies of fish and marine products, fishery environment and culture. Economics is applied in fisheries and also in aquaculture. Statistics is applied to fishery science in stock estimates, yield models, export of products and aquaculture. Application of law for fisheries management is also of importance when over-exploitation leads to depletion of resources. Engineering is applied mainly in fishing and aquaculture and is concerned with fishing gears, equipments, construction of culture ponds and other equipments.

2.6 Classification Systems

Fishery science showed rapid growth after 19th century. So the classification schemes developed earlier do not give separate consideration for this subject.

However, an analysis of the subject in various classification schemes is given below.

2.6.1 Document general classification

General studies on fish such as taxonomy and biology are given under Zoology. Fish technology and aquaculture are classified as applied science in most classification schemes.
2.6.1.1 Colon Classification, 6th Ed.

K92 - Pisces
KZ332 - Fish breeding (Animal husbandry)

2.6.1.2 Dewey Decimal Classification, 20th Ed.

597 - Pisces (fishes). Ichthyology.
639 - Fish breeding.

2.6.1.3 Universal Decimal classification

597 - Pisces (Fishes) Ichthyology
639 - Hunting, Fishing, Breeding
639.2 - Fishing

2.6.2 Document Special Classification

AGRIS

MOO - Fisheries

2.6.3 Abstracting Journals

2.6.3.1 Aquatic Science and Fisheries Abstracts.

63 - Ichthyology
204 - Practical aspects of fisheries
212 - Aquaculture
235 - Fishable stocks

2.6.3.2 Biological Abstracts

Chordata General and systematic Zoology

Wildlife Management, Aquatic
2.6.4 Thesauri & Subject Headings

2.6.4.1 Sears List of Subject Headings

<table>
<thead>
<tr>
<th>Subject</th>
<th>Rank in Universe</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fishes</td>
<td>567, 597</td>
</tr>
<tr>
<td>Fishing</td>
<td>799.1</td>
</tr>
<tr>
<td>Fish Culture</td>
<td>639</td>
</tr>
<tr>
<td>Fisheries</td>
<td>639</td>
</tr>
<tr>
<td>Aquaculture</td>
<td>639</td>
</tr>
</tbody>
</table>

2.6.4.2 Root Thesaurus

<table>
<thead>
<tr>
<th>HY</th>
<th>subject</th>
</tr>
</thead>
<tbody>
<tr>
<td>HYH</td>
<td>Aquaculture</td>
</tr>
<tr>
<td>EYT. H</td>
<td>Pisces = Fishes</td>
</tr>
</tbody>
</table>

2.6.5 Rank in Universe of Subjects

Array of Order 1 - Natural Science
Array of order 2 - Biology
Array of order 3 - Zoology
Array of order 4 - Chordata
Array of order 5 - Pisces (Fishes)

2.7 Development of the Subject

2.7.1 Landmarks

The oldest written record about fishes is by Aristotle (384–322 B.C.) in which the anatomy, physiology and reproductive biology of fishes are given. Record about fishes are found in the work "Auslandiche Fishe" by Bloch
published in 1785. A valuable study of ichthyology is given in Cuvier and Valenciennes work "Historie Naturelle des poissons" published during 1828-1849. Many contributions on systematics and fisheries research were published afterwards. Among these, "Day's Fishes of India" and Munroe's "Fishes of India and Ceylon" give exclusive description with photographs of Indian fishes. The latest catalogue on fishes of commercial interest has been published by FAO as "species identification sheets for fishery purposes" since 1970 [6].

The subject fishery science developed by mid 19th century when a number of expeditions like 'Challenger', 'Valdivia' etc. and a number of marine laboratories were built in various parts of the world. The need to increase fish yield necessitated fisheries administrators and managers to rely on scientific researcher for advice. This helped in proper utilization of available resources and conservation of stock.

Another landmark in the history of Fishery science is the International Convention of Overfishing which was held in 1946. After this, many commissions were established especially by FAO. These commissions became centres for scientific forums but the problem of overfishing continued. This is due to developments in techniques of fishing which increased yield of fish and no limit was imposed on fishing area. This led to the Law of the Sea
Conference which established the 200 mile EEZ as limit for fishing by coastal nations. Still the need to control over-exploitation of some stocks like prawn is causing problem. This has to be managed by each coastal country using proper fishery management policies.

Development of aquaculture is an important event in Fishery science. This increased the production of cultured species. Development of artificial feeds, disease control methods, genetically improved species and artificial fertilization are factors which made aquaculture popular. With the development of recreational fishing, culture of ornamental fishes also increased. Research and developments have increased export of fish and fish products.

2.7.2. Trends in the Subject

Fisheries is an integrated activity directed towards food production and changes in the availability of the resources have affected the catch, processing and marketing. The need to exploit potential fishery resources has focused renewed attention on fish stocks which were neglected or underexploited and on technologies to make use of their exploitation to the maximum possible. Research organizations all over the world have a key role to play in this area. Change in resource availability may be due to stock collapses,
increased fishing costs, global resources limitation and extended fisheries jurisdiction. Reaction to these changes have affected industry and resource management.

Future challenges in the field are in fisheries management, food supplies from fisheries, technological requirements and lack of exploitation of unconventional resources. Organizations like FAO have strengthened their capacity to help developing countries in matters of fishery planning and in various technical fields associated with rational exploitation and utilization of fishery resources. Collaboration of Research Institutes in developing countries with those in developed countries will be beneficial for development of Fisheries science in future.

Major areas of research in fisheries science can be broadly divided into capture and culture fisheries. Based on this, research organizations also constitute their departments. Even though there exist two divisions of fisheries based on the type of water into freshwater and marine, the research methods and techniques associated with both are similar. Research is being conducted in all the divisions of the subject with emphasis on management, culture and technology.

Fish biology research is more fundamental and is useful in identification, occurrence and taxonomy
studies. Research on stock management applies mostly statistical methods for prediction of potential yield such as extrapolation of present trends in catches, extrapolation of resource estimation of a known area to the whole world, estimation of primary production and production at each successive stage. In addition to collection of statistics about stock, formulation of laws and implementing them are important in resource management. Scientific researchers and managers have great responsibility in proper exploitation and management of resources.

Fish ecology research is important in culture and stock management as the ecological factors affect mainly production and aquaculture. Recently stress and its effect on fisheries and bioenergetics of fish are studied as part of ecology.

Effect of pollution on fisheries is an active field of research as it plays an important role in managing the resources. Pollution due to sewage, industrial waste, mining and agricultural waste are increasing and threatening the very existence of many aquatic forms. Fish mortality and diseases due to toxic effects show an upward trend. Measures like legislation in use of pesticides and treatment of wastewater before discharge from factories are introduced in many countries.
Research on fish physiology is a very important field. Physiological aspect covers growth, feeding, nutrition, behaviour etc. It is useful in many areas of fishery science.

In aquaculture, preparation and utilisation of artificial feed helps a lot in culturing fish. Research on growth, reproduction, and behaviour are useful in fishing and selecting fish for culture. Toxic effects of fishes are also part of physiological research. Some toxic materials produced by fish are found beneficial as drugs as they have pharmacological properties like anesthetics.

Research on fish genetics has ushered in a new era of artificial breeding by pituitary gland or hormone injection, hybridization etc. These studies are of immense use in mass producing fish fry for culture in seed farms.

Fish pathology deals with causes and control of diseases. Identifying the causes and introducing control measures are valuable in aquaculture and also for wild stocks when an outbreak of disease is reported. New varieties of fish which are disease resistant are also being introduced.

Fish processing and technology are active fields of research as export of fishes has grown as an industry.
Developments in better means of preservation and distribution have been accompanied by an evolution in the processing of fish products before being delivered to the consumer. A new branch of industrial fisheries concerned with the use of fish products for purposes such as medicine, human food, making paint, ink etc, have evolved. Researchers have an important task of showing how the new fish and shell fish products can be used to the maximum effect. Fish technologists have a key role to play in helping developing countries to make greater use of their fish resources and reduce considerable waste by spoilage or pests. The contribution of fishery scientists on the technology of fishing and properties of fish as food have made possible increase of fish catch and export of fish products.

Aquaculture research has resulted in world-wide increase in fish production by culture. This growth is largely due to the new technologies developed for aquaculture purposes. Artificial breeding and fish seed production in hatcheries in the place of earlier method of collecting fry from natural waters enhance the output of culture products. Research and practice on polyculture or mixed farming are also gaining momentum. Intensive aquaculture, where culture of fish is done along with agriculture, horticulture, piggery, duckery etc. is another area of fruitful research. The hobby of
aquarium fish keeping has led to research on culture and export of ornamental fishes [9].

Aquaculture has led to the development of many scientific disciplines. The choice of culture organisms concerns genetics; transport and protection of animals concerns engineering; care of young concerns ecology and microbiology; nutrition concerns physiology and biochemistry; control of disease pathology etc. Thus many new fields of fishery science research based on modern technologies are leading towards genetic engineering and biotechnology applications.

2.7.3. Trends in Education

'Fishery Science, in the broad sense is the study of exploited aquatic animal resources for the purpose of generating an increased benefit to man' [10]. Fishery education is a diversified field. Fisheries and aquaculture, traditionally based on biology are among the earliest known agricultural activities of man. Ichthyology, the study of fishes emerged as a field distinct from biology and is concerned with taxonomy and natural history of fishes.

Fishery education in leading fishing nations has been evolved to suit their specific needs. In Norway, there are several fisheries schools for training processing technologists but there is no higher level institutions.
'In U.S., Institutes impart instruction in fisheries with strong emphasis on research concerning fisheries resources, fish population dynamics, aquaculture and food science. Canada and England also have graduate and postgraduate courses in fisheries education. In Poland there are fisheries schools and higher level training establishments for management of personnel. In Japan there is an elaborate system of fishery education integrated in the National Education System' [11].

Educational programmes in fishery science are of different kinds depending upon the nations and institutions involved. In most countries formal education in universities is combined with education of the public through extension programmes. In U.S. these extension programmes are part of land-grant University system. Research, teaching and extension in US are supported by Sea Grant Program, a co-operative federal-state-University effort.

In India, fishery education started with training given by fishery Institutes such as Central Inland Fisheries Research Institute establishing Inland Fisheries Training Unit (IFTU) and by Central Marine Fisheries Research Institute. In 1958 a committee of fisheries education was set up which recommended establishment of Central Institutes for education. Then the Central Institute of Fisheries Education (CIFE) and
Central Institute of Fisheries Operatives (CIFO - renamed as Central Institute of Fisheries and Nautical Engineering - CIFNET) were set up in Bombay in 1961 and Madras in 1968 respectively \[11\]. Later, Agricultural Universities began to establish fisheries colleges in different states. In-service training is offered by fisheries departments.

Higher Education in fisheries is based on Biology, Chemistry, Physics, Economics, Statistics etc. Students usually start by taking courses in these basic sciences and proceed to applied sciences like fisheries. Many colleges and Universities in developed and developing countries have programmes leading to graduate and post graduate degree in fisheries science. Specialisations leading to doctorate degrees are awarded in most countries. Many students from developing countries are obtaining advanced degree from developed countries under the International Technical Assistance Programme. Admission to Higher education in fisheries is generally on graduation or through entrance examination. The administration of fisheries colleges and research and extension organizations are by ministry of agriculture which enables coordination between education and research.

Higher education in fishery science is becoming more international due to the serious concern for expanding
world food requirements. International collaboration of scientists, educationists and institutions is increasing. Food and Agricultural Organization also provides assistance in world wide education in fishery science.

2.8 Source of Information

Recent developments in fishery science and technology have resulted in increase in the number of research organizations all over the world. This has led to publication of research papers in the form of reports, bulletins etc in addition to journals, books and reviews. Literature in fishery science grows parallel to the growth of research in the field. The sources of information in fishery science can be divided into documentary, institutional and human sources.

2.8.1 Documentary Sources

Documentary sources are divided into Primary, Secondary and Tertiary.

Primary sources include journals, proceedings, research bulletins, patents, official publication, theses and dissertation. Some examples are:

1. Indian Journal of Fisheries published by Central Marine Fisheries Research Institute, Kochi.
Secondary sources are textbooks, reference books (dictionaries, encyclopaedias, hand books), abstracting journal, review serials and guide books. Few examples are noted below:


2.8.2. Institutional Sources

These include both national international institutions doing research on the area. Some international agencies collect and evaluate facts about resources and provide the information through publication, press release and special presentation. Institutions also conduct seminars symposia and workshops on special topics. These are also published as proceedings. Some institutes also provide data regarding fish resources to those who need it.

Eg.1. International – Inter-American Tropical Tuna Commission (IATTC)

2. National – Central Marine Fisheries Research Institute (India) NMLRDC
Human Sources

Earlier, information in the form of expert opinion formed source of information. Some institutes and organizations provide consultancy service for fish technology, export and aquaculture. Details about such individuals and firms can be obtained from who's who or directories.


Other Sources

These include computer databases, films, networks, etc. With the development of new technologies, online databases can be accessed to get the relevant information quickly.

Eg: AGRIS (Agricultural Information System)

ASFIS (Aquatic Science and Fisheries Information System)

Information Transfer Process

Channels of communication are necessary for information transfer process. This includes producer, processor and receiver who interact in an environment. All these are necessary in any field of research. The
result is secondary and tertiary publication. In an information service, to transfer information quickly to those who need it, new devices are to be found.

In an information system, the author, editor and publisher have responsibilities. Author does basic and applied research and send the result as articles for publishing. Author has to see that the results are authentic and are supported by proper evidence. The editor, mostly journal editor has to see that the articles are properly edited. Publisher has the responsibility to see that the journal does not publish any substandard material. The information thus produced is used by different types of users. Journals and abstracts are mostly used by research workers, textbooks by students, journals and books by teachers. An effective information transfer system has to cater to the needs of all the different type of users.

2.10 Conclusion

Because of active research in the field, the literature in fishery science is increasing in terms of publications, mainly in the form of journals, reports, technical notes and reviews. So it is important that any information centre in this subject field has to do judicious selection of journals for organizing better information services to the users. Citation studies which evaluate the use of journals in a subject helps a
lot in journal selection. A study of the subject, its structure and development as done in this chapter will be of great help in designing an user friendly information system in Fisheries science. The study of the structure and development bring out the limitation in mapping of fishery science in popular classification system now available in the profession.

References


