

Rajarshi Shahu Mahavidyalaya, Latur
(Autonomous)

Fishery Science

CHOICE BASED CREDIT SYSTEM (CBCS)

SEMESTER PATTERN

(W.e.f. Academic Year 2017-18)



SYLLABUS FOR

B.Sc. (Fishery Science)

B. Sc First Year

June-2017

Rajarshi Shahu Mahavidyalaya, Latur

(Autonomous)

BoS in Fishery Science

1. Introduction:

The term fisheries & Aquaculture itself clear its meaning. It is related to catching of inland and marine fishes for commercial purposes. It involves aquaculture, gears, navigation, oceanography, aquarium management, breeding, processing, export and import of seafood, special products and by-products, research and related activities.

Indian fisheries and aquaculture is an important sector of food production, providing nutritional security to the food basket, contributing to the agricultural exports and engaging about fourteen million people in different activities. With diverse resources ranging from deep seas to lakes in the mountains and more than 10% of the global biodiversity in terms of fish and shellfish species, the country has shown continuous and sustained increments in fish production since independence. Constituting about 6.3% of the global fish production, the sector contributes to 1.1% of the GDP and 5.15% of the agricultural GDP. The total fish production of 10.07 million metric tons presently has nearly 65% contribution from the inland sector and nearly the same from culture fisheries. Paradigm shifts in terms of increasing contributions from inland sector and further from aquaculture are significations over the years. With high growth rates, the different facets of marine fisheries, coastal aquaculture, inland fisheries, freshwater aquaculture, coldwater fisheries to food, health, economy, exports, employment and tourism of the country..

B.Sc. Fishery Science is a Three year graduate degree program which is started in the academic year 1983.

"Fisheries science" is the academic discipline of managing and understanding fisheries. It is a multidisciplinary science, which draws on the disciplines of aquaculture including breeding, genetics, biotechnology, nutrition, farming, diagnosis of diseases in fishes, other aquatic resources, medical treatment of aquatic animals; fish processing including curing, canning, freezing, value addition, byproducts and waste utilization, quality assurance and certification, fisheries microbiology, fisheries biochemistry; fisheries resource management including biology, anatomy, taxonomy, physiology, population dynamics; fisheries environment including oceanography, limnology, ecology, biodiversity, aquatic

pollution; fishing technology including gear and craft engineering, navigation and seamanship, marine engines; fisheries economics and management and fisheries extension. Fisheries education in India, started with the establishment of the Central Institute of Fisheries Education, Mumbai in 1961 for in service training and later the establishment of the first Fisheries College at Mangalore under the State Agricultural University (SAU) system in 1969, has grown manifold and evolved in the last four decades as a professional discipline consisting of Bachelor's, Master's and Doctoral programmes in various branches of Fisheries Science.

With reference to global changes occurring in higher education in various national and international universities, the syllabi of B.Sc. Fishery Science is designed which is to be effectively implemented from June, 2017. The committee members of BoS in fishery science also took the local need and employability of graduate students while framing the syllabus, In order to make students employable, they must have thorough understanding of aquaculture engineering. Experts suggested to introduce one separate paper on 'Aquaculture Engineering and Technology' for third year students. Keeping in view of the guidelines given in the UGC curriculum. The number of objectives is taken into consideration while reforming the syllabi. To create aqua culturist, farm managers, exporters, traders, breeders and modern fishermen etc.

2. Learning Objectives of the Programme:

Objective of Fisheries Education: This syllabus has been developed within the parameters set by the Board of Studies

To make available the much needed technically competent extension personnel for transfer of technology.

- To make available personnel to assist the research and development & instructors to teach.
- To make available administrators to plan, develop & execute fisheries development plan.
- Motivate students to increase their individual talents and capabilities for lifelong learning
- enable all students to develop positive self-concepts and their capacity to establish and maintain safe, healthy and rewarding lives
- prepare all students for effective and responsible participation in their society, taking account of moral, ethical and scientific considerations

- Encourage and enable all students to enjoy learning, and to be self-motivated, reflective, competent learners who will be able to take part in further study, work or training in various institute of fisheries education .
- promote a fair and just society that values diversity, ecology and environment
- knowledge, understanding and appreciation of marine and aquatic environments
- knowledge, understanding and appreciation of the role of aquaculture in the preservation of wild seafood stocks and the marine environment

4. Programme Specific outcomes/ Programme Outcomes:

This three-year graduate programme provides students with specialized knowledge and professional skills to prepare them for a career in the rapidly-growing field aquaculture.

Upon completion of the program, a successful graduate will be able to:

- Utilize the developed expertise in concepts, theories, and emerging methodologies to succeed in tackling real-world issues in aquaculture and aquatic science.
- Demonstrate advanced knowledge and competency in taxonomy and natural history of aquatic flora and fauna
- Demonstrate hands-on experience in aquatic sampling inventory and measurement techniques.
- Become an independent, self-motivated professional with the ability to recognize problems in their field of aquaculture and aquatic science and apply critical thinking and problem-solving skills.
- Engage in independent research in growing field of aquaculture.
- Apply practical and theoretical knowledge for aquaculture research and extension.
- be productive, creative and confident in the use of technology and understand the impact of technology on society
- understand, develop and communicate ideas and information

5. Advantages of the Course:

Recent advances in fisheries are included in course. Which focuses on the fishing sector For example, it uses Biology and Physical Science concepts to study fish, their ecosystem, their food habits, diseases occurring in them, modulation in immune system and breeding, hybridization, making fish feed and understanding feed technology, fishery market structure, genetics, biodiversity etc. Also, scientific concepts are used in stages like catching, processing, packing fish and fish products, preserving them and later transporting them to other places.

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| 6. Duration of the Course: | Three years |
| 7. Eligibility of the Course: | 12th science |
| 8. Strength of the Students: | 30 |
| 9. Fees for Course: | As per University/College rules. |
| 10. Admission / Selection procedure: | Admission by merit through Registration |
| 11. Teacher's qualifications: | As per UGC/University/College rules |
| 12. Standard of Passing: | As per UGC/University/College rules |
| 13. Nature of question paper with scheme of marking: | As per UGC/University/College rules |
| 14. List of book recommended: | Included in syllabus |
| 15. List of Laboratory Equipment's, Instruments, and Measurements etc.: | |
| 16. Rules and regulations and ordinance if any: | As per UGC/University/College rules |
| 17. Course duration: | Each theory course is of 45 Contact hours |
| 18. Medium of the language: | English |

RAJARSHI SHAHU MAHAVIDYALAYA, (AUTONOMOUS) LATUR

Choice Based Credit System (CBCS) Course Structure

Faculty of Science

B. Sc First Year (Semester- I & II)

Distribution of credits for B.Sc. Fishery Science

Under Graduate (UG) programmes

B. Sc. Syllabus structure effective from June 2017

Subject: Fishery Science

Semester	Paper No.		Name of the Course	Instruction Hrs/ week	Total period	Total Marks		Credits MARKS 50
	Course Code					EXTERNAL (ESE)	INTERNAL (CA)	
Semester I	Paper I (CCF-1)	SECTION A	Taxonomy, Ecology and General topics	03	45	30	20	2
	Paper II CCF-2	SECTION B	Morphology, Anatomy and Physiology	03	45	30	20	2
	Practical I CCFP -1		Lab Course I	03	07	30	20	2

Semester II	Paper III CCF-3	SECTION A	Fish seed production technology	03	45	30	20	2
	Paper IV CCF-4	SECTION B	Indian fisheries, Brackish water and Mericulture	03	45	30	20	2
	Practical II CCFP-2		Lab Course II	03	07	30	20	2

RAJARSHI SHAHU MAHAVIDYALAYA, (AUTONOMOUS) LATUR.

Choice Based Credit System (CBCS) Course Structure

Faculty of Science

B. Sc First Year (Semester- I)

W.e.f. June 2016

Subject: FISHERY SCIENCE

Paper I: TAXONOMY, ECOLOGY AND GENERAL TOPICS

Course Code: CCF-1

Marks – 50

Hours 45

Credits – 2

Objectives

1. This course has been designed to understand identification and classification of commercially important fishes and other aquatic vertebrates by the students.
2. The course objectives are to provide the students with an introductory knowledge of fish classification.
3. The students will be able to identify common species available in and around their region using morphological keys. .
4. Enable students to understand special adaptive features in fishes like light producing, Electric, Sound producing organs, Poison glands, etc.

Course Outcomes

After successful completion of the course the students will:

1. Develop an understanding of the role of taxonomy in identification of fishes.
2. On completion of the course the student should have obtained valuable skills in fish taxonomy and ecology including adaptive features of fishes.
3. Identifies, describes and evaluates the scientific importance of fish taxonomy.
4. Identifies, describes common species available in and around their region using morphological keys. .
5. Identifies, describes and evaluates policies for monitoring and conserving the marine environment.
6. Identifies, describes and evaluates the social and economic importance of marine ecosystems.
7. identify the adaptations of special adaptive features of fishes

UNIT I

12 hrs

1. Introduction, definition, scope and importance of fishery science
2. **Origin and Evolution of fishes** – Origin of cartilaginous and bony fishes, Evolution of fishes.
3. General characters, Identification and systematic position of fishes among chordates.
4. **Broad outline Classification of fishes** Introduction, classification up to class level. (Berg, 1940, Romer, Bertin and Arambourg, Greenwood *et. al.*, Lander, Lien and Pough *et. al.*) .

5. Fish identification techniques.

- a. Study of morphometric characters in fishes.
- b. Study of meristic characters in fishes
- c. Study of anatomical characters in fishes.

UNIT:-II

10 hrs

1. Introduction, self regulation of stock density in the event of change in food supply. Primary productivity of water mass and fish production, Trophic levels of fish in the food chain, pyramid of numbers and fish communities in it. Predator-prey relationship.
2. Physico-chemical properties of freshwater and marine water.
3. Ecology of freshwater- Lakes, rivers, streams, reservoirs and lakes.
4. Ecology of Sea and estuaries and mangroves
5. Plankton and blooms.

UNIT:-III

12hrs

1. **Migration in fishes**- General account of migration, types of migration, advantages of migration and factors influencing migration.
2. **Air bladder**- Location of air bladder, different types of air bladder, their Structure and functions.
3. **Weberian ossicles in fishes** – structure and functions.
4. Parental care in fishes.

UNIT IV

11hrs

1. **Light producing organs in fishes** – occurrence, nature, location and structure of light producing organs, significance of luminescence in fishes.
2. **Electric organs in fishes** – Occurrence, location and general structure and functions of electric organ. Electric organs in *Torpedo* and Electric eel.
3. **Sound producing organs in fishes** - Location, structure and functions.
4. **Poison glands in fishes** – Location, structure and functions. Difference between poisonous and venomous fishes.

RAJARSHI SHAHU MAHAVIDYALAYA, (AUTONOMOUS) LATUR.
Choice Based Credit System (CBCS) Course Structure

Faculty of Science
B. Sc First Year (Semester- I)
W.e.f. June 2016
Subject: FISHERY SCIENCE
Lab Course I:
Course Code: CCF-2

Marks – 50	Hours 30	Credits – 1
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Objective

5. This course has been designed to understand identification and classification of commercially important fishes and other aquatic vertebrates by the students.
6. The course objectives are to provide the students with an introductory knowledge of fish classification.

Course Outcomes

After successful completion of the course the students will:

8. Develop an understanding of the role of taxonomy in identification of fishes.
9. Identifies, describes and evaluates the scientific importance of fish taxonomy & morphology
10. Identifies, describes common species available in and around their region using morphological keys. .
11. Identifies, describes and evaluates fish scales
12. Identifies, describes and evaluates the social and economic importance of marine ecosystems.
13. identify the adaptations of special adaptive features of fishes

1. **Fish identification techniques** (any locally available fish)
 - a) Study of any five morphometric characters.
 - b) Study of any five meristic characters.
2. **Identification, Classification and diagnostic characters** –
 - i) Freshwater fishes (any 5)
 - ii) Marine water fishes (any 5)
 - iii) Adaptations in fishes (any 5)
 - iv) Fishes with specialized organs (any 5)

3. **Permanent mounting of fish scales and submission of prepared slides –**
 - a) Placoid b) Cycloid c) Ctenoid

4. **Water analysis -**
 - a) Dissolved oxygen b) Dissolved CO₂ c) Chlorides d) Carbonates
 - e) Sulphur f) Nitrogen g) pH by pH meter

5. **Collection. Identification of planktons and submission of plankton slides-**
 - a) Freshwater phytoplankton and zooplankton.
 - b) Marine phytoplankton and zooplankton.

6. **DEMONSTRATION (*Labeo*):**
 - i) Digestive system, ii) Urinogenital system (male and female),
 - iii) Gills, Ventral aorta and afferent branchial arteries,
 - iv) Brain and Cranial nerves. v) Air bladder, vi) Weberian ossicles

7. **Skeleton study:**
 - i) Trunk vertebra, ii) Caudal vertebra
 - iii) Pectoral girdle, iv) Pelvic girdle

8. Visit to a water reservoir to study its ecology.

Books Recommended for Paper I and II

- 1. Text book of Fish Biology and Fisheries** - By S. S. Khanna and H. R. Singh (2003 Ed.), Narendra Publishing House, Delhi – 110006
- 2. Encyclopedia of Fishes and Fisheries of India** – By A. K. Pandey and G. S. Sandhu, Vol I to IV, Amol Publications, New Delhi.
- 3. A text book of Fishery Science and Indian Fisheries** – By C.B.L. Srivastava (Kitab Mahal)
- 4. An Introduction to Fishes** – S. S. Khanna, Central Book Depot, Allahabad.
- 5. The Ecology of fishes** – By G. Y. Nikolski. Academic Press
- 6. Growth and Ecology of Fish Population** – By A. H. Weatherley Academic Press.
- 7. Fish and Fisheries** – By B. N. Yadav. Daya Publishing House, Delhi.
- 8. History of fishes** – J.R. Norman. Ernest Benn. Ltd., London.
- 9. Ecology and Environment** – By P.D. Sharma. Rastogi Publications, Meerut.
- 10. A manual of Freshwater Ecology** – By R. Santharam, P. Velayutham and G. Tegatheesan. Daya Publishing House, New Delhi.
- 11. General and applied ichthyology** – S.K. Gupta, P.G. Gupta, S. Chand Publishing Co., New Delhi.
- 12. Text book of fish, fisheries and technology** – K.P. Biswas, Narendra Publishing House, New Delhi.
- 13. An Introduction to fishes** – H.S.L. Bhamrah and K. Juneja, Anmol Publication, New Delhi.

RAJARSHI SHAHU MAHAVIDYALAYA, (AUTONOMOUS) LATUR.
Choice Based Credit System (CBCS) Course Structure

Faculty of Science
B.Sc. F.Y. (First Semester)

w.e.f. June 2016

Subject: FISHERY SCIENCE

Paper II: MORPHOLOGY, ANATOMY AND PHYSIOLOGY

Course Code: CCFP-I

Marks – 50

Hours 45

Credits – 2

Objective

1. Enable students to understand structure, types, functions of Teeth & Gill rakers, Digestive System, Respiratory system, Cardiovascular System, Nervous system, Excretory system, Reproductive system and skeleton system
2. To understated the structure and functions of sense organs.
3. This is accomplished through lecture, class discussion and examination of selected specimens by showing power point presentation, animated video of organ structure and function.
4. This course has been designed to understand morphology of fishes viz.body forms Fins and their functions.

Course Outcomes

After successful completion of the course the students will:

1. Develop an understanding of the role of anatomy and physiology in study of fishes.
2. On completion of the course the student should have obtained valuable skills in fish anatomy and physiology including regulatory mechanisms.
3. Recalls aspects of the internal body organization using relevant conventions, terminology.
4. Students will capable to differentiate morphological features of various species of fishes.

Unit – I**10 hrs**

- i) Introduction and External Characters of Fishes.
- ii) Body forms in fishes
- iii) **Locomotion in fishes** – Types of locomotion.
- vi) **Fins and their functions** – Types of median and paired fins and their origin, Gill arch theory and fin fold theory
- v) Structure and Functions of skin, Types of Scales and their uses, Coloration.

Unit –II**12 hrs**

- i) **Teeth & Gill rakers:** structure, types, function and modifications.
- ii) **Food:** Types of food and feeding habits.
- iii) **Digestive System** – Coelom and Alimentary canal, Associated glands – Liver, Pancreas, Gall bladder, Physiology of digestion.
- iv) **Respiratory system** – Structure and functions of gills and physiology of respiration.
- v) **Cardiovascular System** – a) Structure of heart b) Arterial system- Ventral aorta and afferent branchial vessels, dorsal aorta and its branches. c) Venous system – Anterior cardinal system, posterior cardinal system, Hepatic portal system. d) Composition of blood.

Unit –III**12 hrs**

- iv) **Nervous system** – Structure of brain, Cranial nerves their origin and distribution
- v) **Excretory system** – Types, structure and functions of kidney, Physiology of excretion.
- vi) **Endoskeleton** – a) **Axial Skeleton** – Typical trunk vertebra, caudal vertebra.
b) **Appendicular Skeleton** – Pectoral girdle and fin and Pelvic girdle and fin.
- vii) **Reproductive system** – Male and female reproductive organs, maturation and spawning.

A) Sense organs

- i) Lateral line canals-** Structure and functions.
- ii) Pit organs -** Structure and functions.
- iii) Internal ear (membranous labyrinth) -** Structure and functions.
- iv) Olfactory organs -** Structure and functions.
- v) Photoreceptor organ (eye) -** Structure and functions.

B) Endocrine glands in fishes – Structure and functions of pituitary and Thyroid Gland.



RAJARSHI SHAHU MAHA VIDYALAYA, (AUTONOMOUS) LATUR.

Course Structure

B.Sc. F.Y (Second Semester)

❖ Paper III: FISH SEED PRODUCTION TECHNOLOGY
Course Code :CCF-3

❖ Paper IV: INDIAN FISHERIES, BRACKISH WATER AND
MERICULTURE
Course Code : CCF-4

❖ Lab Course II: PRACTICALS
Course Code : CCF-I

CBCS PATTERN

RAJARSHI SHAHU MAHAVIDYALAYA, (AUTONOMOUS) LATUR.

Choice Based Credit System (CBCS) Course Structure

Faculty of Science

B.Sc. F.Y (Second Semester)

W.e.f. June 2016

Subject: FISHERY SCIENCE

Paper III: FISH SEED PRODUCTION TECHNOLOGY

Course Code: CCF-3

Marks – 50

Hours 45

Credits – 2

Objectives

1. Enable students to understand the Breeding Techniques
2. Enable students to understand Fish seed trade and transport
3. Enable students to understand Hatcheries and management (Principle, structure and management)
4. Enable students to understand different river systems of India.

Course Outcomes

After successful completion of the course the students will:

1. Develop an understanding of different Breeding Techniques and modern method.
2. recalls aspects of the riverine environment using relevant conventions, terminology and symbols
3. Demonstrates safe and responsible use of a range of materials use in hatchery management in different aquaculture system.
4. Demonstrates safe and responsible use of pituitary injection.
5. Students are enabling to design different hatchery models.
6. Enables students to understand behavior of spawn in relation to hydro biological characters.

Unit –I

12hrs

Breeding Techniques

- A) Bundh breeding- Types of bundhs –i) dry bundhs b) Wet bundhs c) Modern bundhs
- B) Artificial fertilization by stripping
- C) Induced breeding by hypophysation – i) Definition ii)Hormones responsible for induced breeding iii) Dissection and removal of pituitary

gland iv) Preservation and storage of pituitary gland. V) Preparation of gland suspension for injection and dosage. I) Collection, rearing and selection of brooders vii) Synthetic hormones used in induced breeding.

Unit –II

12hrs

Fish seed trade and transport

- i) classification of fish seed and identification techniques
- ii) different units of fish seed counting
- iii) fish seed trade in india
- iv) fish seed transportation system – open and close transportation system.
- v) causes of mortality in transportation,
- vi) use of chemicals in live fish transportation.
- vii) anesthetic drugs used in transport.
- viii) antiseptic and antibiotics used in transportation.
- ix) technique of fish seed release.

Unit –III

10hrs

Hatcheries and management (Principle, structure and management)

- i) Hatching hapa
- ii) Glass jar hatchery
- iii) Bin hatchery
- iv) CIFE D 80model (Dwivedi - 80)
- v) CIFE D 81 model (Dwivedi - 81)
- vi) Chinese hatchery

Unit-IV

11hrs

- i) The Ganga River system
- ii) Bramhaputra river system
- iii) Riverine spawn resources investigation technique – Selection of spawn collection site, Gears used for collection of spawn and their diversities, Methods of collection of spawn.
- iv) Behavior of spawn in relation to hydrobiological characters.
- v) Present status and future prospects of freshwater fish seed in India.

Books and References Recommended for Paper-III

1. Bardach, J.E.W (1972) Aquaculture farming and husbandry of freshwater and marine organisms
2. Thomas P.C (Ed) Current and emerging trends in aquaculture
3. Coche, A.G., Muir, J.F. Simple methods for aquaculture: Pond construction for freshwater
4. Introduction to aquaculture Pillai, T.V.R., Aquaculture principles and practices
5. Jonathan Shepherd, C. (Ed) Intensive Fish Farming
10. William Royce, F., An introduction to the practice of fishery science.
11. Planning of Aquaculture Development. FAO, Fishing News Books
12. Advances in Aquaculture. FAO, Fishing News Books.
13. Pullin, R.S.V. and Chehadeh, Z.H. (Eds.). Integrated Agriculture-Aquaculture Farming Systems. ICLARM.
- 14 Aquaculture Systems and Practices – A Selected Review. UNDP, FAO

RAJARSHI SHAHU MAHAVIDYALAYA, (AUTONOMOUS) LATUR.
Choice Based Credit System (CBCS) Course Structure
Faculty of Science
B.Sc. F.Y. (Second Semester)
W.e.f. June 2016
Subject: FISHERY SCIENCE
Paper IV: INDIAN FISHERIES, BRACKISH WATER AND MERICULTURE
Course Code: CCF-4

Marks – 50

Hours 45

Credits – 2

Objectives

Students will develop Knowledge, understanding and appreciation of marine and aquatic environments

1. Enable students to understand the Oil Sardine, Bombay duck, Mackerel fishery.
2. Enable students to understand brackish water and Mericulture.
3. Enable students to understand Study of important estuaries of India and their fisheries.
4. Enable students to understand Study of different river system in India.
5. To acquaint the students with diversities in different marine fishes and their life.

Course Outcomes

After successful completion of the course the students will:

1. identifies and describes a range of marine ecosystems and investigates their complex interrelationships
2. identifies, describes and evaluates the social and economic importance of brackish and marine water fish culture
3. Enables student to understand about different fishery activity in marine water.
4. Selects and uses a broad range of contemporary materials, equipment and techniques with confidence in aquaculture and marine settings.
5. Explains why aquaculture provides an economically sustainable source of food.
6. Students learn to culture different non fish organisms and plants.

UNIT I:

12hrs

1. Oil Sardine fishery
2. Bombay duck fishery
3. Mackerel fishery.
4. Shrimp fishery.

UNIT II:

12hrs

1. Hilsa fishery.
2. Pomfret fishery.
3. Mollusc fishery (Cephalopod, Chanks)
4. Tuna fishery.
5. Sole fishery.

UNIT III:

11 hrs

Brackishwater and Mericulture:

1. Fin fish culture
2. Shrimp culture.
3. Mussel culture (Edible)
4. Pearl culture.
5. Sea weed culture.

UNIT IV:

10hrs

Study of important estuaries of India and their fisheries:

1. Hoogly – Malda estuary.
2. Chilika lake.
3. Pulicat lake.
4. Kolleru lake.

RAJARSHI SHAHU MAHAVIDYALAYA, (AUTONOMOUS) LATUR.
Choice Based Credit System (CBCS) Course Structure

Faculty of Science
B.Sc. F.Y. (Second Semester)
W.e.f. June 2016
Subject: FISHERY SCIENCE
Lab Course II:
Course Code: CCFP-II

Marks – 50

Hours 30

Credits – 1

Objectives

Students will develop Knowledge, understanding and appreciation of marine and aquatic environments

6. Enable students to understand the Oil Sardine, Bombay duck, Mackerel fishery.
7. Enable students to understand Dry or seasonal bundh and Wet or perennial bundh.
8. Enable students to understand Identification of spawn, fry, fingerling of *Catla catla*, *Labeo rohita* and *Cirrhina mrigala*.
9. Enable students to understand Removal of Pituitary gland, Preservation of pituitary glands, Preparation of pituitary gland extract for injection, Determination of dose for injection.
10. To acquaint the students with Study of principle and working of Hatcheries.

Course Outcomes

After successful completion of the course the students will:

7. identifies and describes a range of marine ecosystems and investigates their complex interrelationships
8. identifies, describes and evaluates the social and economic importance of brackish and marine water fish culture
9. Enables student to understand about structure and construction of Dry or seasonal bundh and Wet or perennial bundh.
10. Selects and uses a broad range of contemporary materials, equipment and techniques with confidence in aquaculture and marine settings.
11. Explains Study of principle and working of Hatcheries viz. Glass jar hatchery, Bin hatchery, Modern carp hatchery, Hatching hapa, Chinese hatchery

1. **Study of Bundhs** – Dry or seasonal bundh and Wet or perennial bundh.

2. **Study of fish seed** – Identification of spawn, fry, fingerling of *Catla catla*, *Labeo rohita* and *Cirrhina mrigala*.

3. **Hypophysation study**

Removal of Pituitary gland, Preservation of pituitary glands, Preparation of pituitary gland extract for injection, Determination of dose for injection.

4. Study of fish seed collection gears.

5. Study of Fish seed transportation.

6. Study of marine fishes:

1. Oil Sardine (*Sardinella longiceps*)
2. Bombay duck (*Harpodon neherius*)
3. Mackerel (*Rastrelliger kanagurta*)
4. Shrimp species
5. Hilsa (*Hilsa ilisha*)
- 6 Pomfret (*Stromateus* species)
7. Mollusc (Edible species)
8. Pearl Oyster (*Pinctata fucata*)

7. Study of principle and working of Hatcheries:

- i) Glass jar hatchery ii) Bin hatchery iii) Modern carp hatchery
- iv) Hatching hapa v) Chinese hatchery

8. Visit to fish seed production center.

Books and References Recommended for Paper III and IV

1. Jhingran and Srivastava (1983) Fisheries Development in India. Concept Publishing Co. New Delhi, 606p

Srivastava and Vathsala (1984) Strategy for development of Inland fisheries resource of India. Concept Publishing Co. New Delhi

3. Panayotou, T. (1982) Management concepts for small scale fisheries Economic and Social aspects. Fisheries Tech. Tech. Pap. No. 228. Rome.

4. Cunningham, D and Whitmarsh, (1985) Fisheries economics, an introduction.

5. IRDC (1982) Aquaculture economic research in Asia. Singapore.

6. Anderson.L. (1977) The economics of fisheries management. John Hopkins.

7. Geoffrey Waugh. Fisheries Management – Theoretical developments and contemporary applications.

8. Ian Chaston. Managerial effectiveness in fisheries and aquaculture.

9. Colin Clark, W., Bioeconomic modeling and fisheries management.

10. Revin Crean and David Symes (Ed), Fisheries management in crisis.

11. Subba Rao, N., Fisheries development and management in India.

12. Ian Chaston, Business management in fisheries and aquaculture.

13. Rowena Lawson, Economics of fisheries development.