


DEPARTMENT OF FISHERIES BIOLOGY, COLLEGE OF FISHERIES, RATNAGIRI




Department of Fisheries Biology is the *Mother department* of Fisheries since it touches almost all the aspects of fisheries science more or less. In keeping with the time, however, the department has updated itself with new subjects and streams to cater for the demands in the fishery sector. The change of emphasis is in the direction of starting post graduate courses in *Fisheries Resources Management*.

Staff: The department has a total teaching staff of eight members under the designations of :

a) Professor & Head (1), b) Associate Professor (2), c) Assistant Professor (5). The Professor & Head, the Associate Professors and the Assistant Professors have obtained their doctorate degrees. The staff members have already upgraded themselves in the emerging fields of Fisheries Resources Management by undergoing various trainings, seminars and workshops.

STAFF STRUCTURE OF DEPARTMENT OF FISHERIES BIOLOGY

	Name of the Faculty	Dr. (Mrs.) Swapnaja A. Mohite
	Post held	Professor (CAS) & Head
	Date of birth	03.05.1963
	Qualification	M.Sc. (Fisheries Management), Ph.D. (Aquaculture), M.Ed.
	Area of specialization	Fisheries resources management; Fisheries biotechnology
	Experience (Year)	29 Years
	Research Projects guided	3
	Ph.D.	1
	M.F.Sc./M.Tech	10
Present area of research	Taxonomy of finfishes and shellfishes, Sponges and associated organisms, Karyotyping of shellfishes, Truss morphometry	
Contact details		
Land line No.	02352-232241	
Mobile	9545030642	
Fax	02352 – 232987	
Email	sa_mohite@yahoo.co.in	
	Name of the Faculty	Dr. Ravindra Pawar
	Post held	Professor (CAS)
	Date of birth	19.03.1970
	Qualification	M.Sc. (Fisheries Management) Ph.D. (Marine Biology)
	Area of specialization	Fisheries resources management; Fisheries biotechnology

	Experience (Year)	23 years
	Research Projects guided Ph.D. M.F.Sc./M.Tech B.Tech.	4 1 15
	Present area of research	Marine discards and bycatch; Evolution of sexual size dimorphism in fishes, Stock assessment and population dynamics
	Contact details Land line No. Mobile Fax Email	02352 – 232241 827563 5577 02352 – 232987 ravindra.fisheries@gmail.com
	Name of the Faculty	B.P.Bhosale
	Post held	Assistant Professor
	Date of birth	1.6.1965
	Qualification	M.Sc. (FPTM)
	Area of specialization	Fisheries Resource Management
	Experience (Year)	27 years
	Research Projects guided Ph.D. M.F.Sc./M.Tech B.Tech.	4 - 7
	Present area of research	Biological studies of commercially important species, Indigenous Knowledge in Fisheries,
Contact details Land line No. Mobile Fax Email	02352 - 232241 94222965850 02352 – 232987 bhosalbp@yahoo.co.in	
	Name of the Faculty	Dr. V.H.Nirmale
	Post held	Assistant Professor
	Date of birth	11.10.1974
	Qualification	M. Sc. (FRM), Ph.D. (FRM)
	Area of specialization	Fisheries Resource Management
	Experience (Year)	15 years
	Research Projects guided Ph.D. M.F.Sc./M.Tech B.Tech.	4 - 7

	Present area of research	Biological studies of commercially important species, Indigenous Knowledge in Fisheries, Truss morphometry, Ethnotaxonomy
	Contact details Land line No. Mobile Fax Email	02352 – 232241 (Ext. 212) 9405685268 02352 – 232987 viveknirmale416@gmail.com

Education:

The department is conducting all the UG courses assigned to it as per the new syllabus laid down by ICAR. Students are taken for field collections, visits and tours etc. as per the demand of the courses.

The department has already started M.F.Sc. courses, initially in Fisheries Biology stream and then in the disciplines of *Fisheries Resources Management* and *Fish Biotechnology*. All the staff members of the department are recognized as Post Graduate teachers to guide the P.G. students in these disciplines. After the up gradation of these two disciplines, the strength of the students has been increased to six. So far, 39 students of M.F.Sc. (FRM) and 22 students of M.F.Sc.(FBT) were awarded degree from the department of Fisheries Biology. Since 2012-13, the department has started Ph.D. (Fisheries Resources Management) with intake capacity of one student. So far 4 students have been awarded Ph.D. degree from this department.

2. ACADEMIC PROGRAMMES:

2.1.U.G. Syllabus of Department of Fisheries Biology

Semester	Course Code & Credits	Topics	
		SEMESTER-I	11+11 = 22
I	FRM 111 3 (1 + 2)	Taxonomy of Finfish	
	Theory		
	1	Principles of taxonomy. Nomenclature, types.	5
	2-3	Introduction to modern taxonomic tools: karyotaxonomy, DNA barcoding, protein analysis and DNA polymorphism.	5
	4	Classification and interrelationships.	5
	5-6	Criteria for generic and specific identification.	5
	7-8	Morphological, morphometric and meristic characteristics of taxonomic significance.	10
	9-10	Major taxa of inland fishes up to family level.	20
	11-12	Major taxa of marine fishes up to family level.	20
	13 – 16	Commercially important freshwater and marine fishes of India and their morphological characteristics.	30

	Practical		
	1-10	Collection and identification of commercially important inland and marine fishes.	
	11 – 15	Study of their external morphology and diagnostic features.	
	16- 19	Modern taxonomic tools - Protein analysis and electrophoretic studies.	
	20 – 22	Karyotaxonomy - chromosome preparation and identification.	
	23 – 25	DNA barcoding, DNA polymorphism.	
	26 – 32	Visit to fish landing centres to study commercially important fishes and catch composition.	
Suggested Readings :			
Bal D.V. & Rao K.V. 1990. Marine Fishes of India. 1st Revised Ed. Tata McGraw Hill. Jhingran V.G. Commercial sea fishes of India, Mayer E. 1977, Principle of Systematic Zoology, Tata McGraw Hill. Khanna S.S. 1993, An Introduction to Fishes. Central Book Depot. P.B.Moyle and J.J. Cech, Fishes: An Introduction to Ichthyology. K.F.Laglar, J.E.Bardacg, R.R.Miller, Ichthyology, K.C.Jayram, Freshwater fishes of the Indian Region			
I	FRM 112 2 (1 + 1)	Taxonomy of Shellfish	
	Theory		
	1-4	Study of external morphology and meristic characteristics of crustacean.	15
	5-8	Study of external morphology and meristic characteristics of mollusca.	15
	9-12	Classification of crustacea up to the level of species with examples of commercially important species.	35
	13-16	Classification of mollusca up to the level of species with examples of commercially important species.	35
	Practical		
	1-2	Study of external morphology.	
	3-13	Collection, preservation and identification of commercially important prawns, shrimps, crabs, lobsters, bivalves, gastropods, cephalopods from natural habitats.	
	14-16	Field visits for collection and study of commercially important shellfishes.	
Suggested Readings :			
Kurian CV & Sebastian VO. 1986. Prawns and Prawn Fisheries of India. Hindustan Publ. Corp. Saxena A..2005 Text book of Crustacea. Discovery Publishing House, New Delhi. Castro P & Huber ME. 1997. Marine Biology. 2nd Ed. Mc-Graw Hill. Linder G. 1977 Sea shells of the world. Blandford PressLtd.Dorset. Ede DA. 1978. An Introduction to Developmental Biology. Blackie.			
		SEMESTER-II	13+ 8 = 21
II	FRM 123 3 (2 + 1)	Anatomy and Biology of Finfish	
	Theory		
	1-5	Study of external and internal anatomy of important groups of finfish.	5
	6-7	Study of oral region and associated structures.	5
	8-10	Digestive system and associated digestive glands.	10
	11-15	Food and feeding habits of commercially important fishes.	5
	16-18	Qualitative and quantitative methods of analysis of gut contents.	5
	19-24	Circulatory system, respiratory system, nervous system, urino-genital system, endocrine system, skeletal systems and sensory organs.	20
	25 - 27	Reproductive biology – maturity stages, gonado-somatic index, ponderal index, fecundity, sex ratio and spawning.	10
	28-29	Eggs and larval stages and developmental biology.	10
	30	Age and growth determination by direct and indirect methods.	10
	31	Fish migration - type and significance.	10
	32	Tagging and marking.	10

	Practical		
	1-5	Study of internal organs – digestive, respiratory, circulatory, urino-genital system, nervous systems.	
	6	Skeletal systems.	
	7	Endocrine system.	
	8-10	Study of food and feeding habits. Analysis of gut contents.	
	11-12	Estimation of age and growth by direct and indirect methods.	
	13-14	Classification of maturity stages. Estimation of fecundity.	
	15	Study of developmental stages.	
	16	Tagging and marking.	
Suggested readings :			
<p>Khanna, S. S., & Singh, H. R. (2011). A text book of fish biology and fisheries. Narendra Publishing House.</p> <p>Wilhelm Harder: 1976 Anatomy of fishes. Schweizerbart science publishers.</p> <p>Evans, D. H., Claiborne, J. B. and Currie S. The Physiology of Fishes, Fourth Edition CRC Marine Biology Series.</p> <p>Rajiv Tyagi and Arvind N. Shukla, Anatomy of fishes.</p> <p>J.S.Datta Munshi and G.H.Hughes, Air breathing fishes of India, their structure, function and life history.</p>			
II	FRM 124 2 (1 + 1)	Anatomy and Biology of Shellfish	
	Theory		
	1	Study of external and internal organization of commercially important crustaceans.	5
	2	Study of external and internal organization of commercially important molluscs.	15
	3-4	Digestive system, Food and feeding habits,	10
	5-8	Respiratory, circulatory, nervous and reproductive systems.	20
	9-10	Growth and moulting.	10
	11-12	Length – weight relationship.	10
	13-14	Age and growth determination by direct and indirect methods.	10
	15-16	Reproductive biology, larval stages.	10
	Practical		
	1	Study of internal organs of commercially important crustaceans.	
	2	Study of internal organs of commercially important molluscs.	
	3-7	Study of Digestive, respiratory, circulatory, nervous and reproductive systems.	
	8-10	Study of food and feeding habits - analysis of gut contents.	
	11-14	Age and growth, length - weight relationship and condition.	
	15-16	Reproductive biology: maturity stages, spawning periodicity, fecundity and larval stages.	
Suggested readings:-			
<p>Adiyodi KG & Adiyodi RG. 2000. Reproductive Biology of Invertebrates: Vol. X. Part B. John Wiley & Sons. Progress in Developmental Endocrinology.</p> <p>Saxena AB. 1996. Life of Crustaceans. Recent Advance in Entomology, Series -10. Anmol Publ.</p> <p>Barrington EJW. 1981. Invertebrate Structure and Function. 2nd Ed. The English Language Book Society & Nelson.</p> <p>The biology of crustacean, Vol I to IX.</p> <p>C.M. Yonge & T.E.Thompson, Living marine mollusks.</p>			
SEMESTER-III			14+ 9 = 23
III	FRM 235 3 (2 + 1)	Inland Fisheries	
	Theory		
	1-5	Freshwater fishery regions of the world and Maharashtra and their major fish species composition.	5

	7-9	Global inland fish production data.	5
	10-12	Capture fishery resources of India.	10
	13-15	Potential of inland water bodies with reference to respective state.	10
	16 -19	Estimation of Inland fish production and problems in the estimation of inland fish catch data.	10
	20-21	Fishing crafts and gears of Maharashtra.	10
	22-24	Major riverine and estuarine systems of India.	10
	25-26	Major brackish water lakes and their fisheries.	5
	27-29	Fisheries of major reservoirs / natural lakes of India.	15
	30-31	Flood-plain capture fishery- present status of their exploitation and future prospects.	10
	32	Cold water fisheries of India.	10
	Practical		
	1-5	Analysis of species composition of commercial catches at landing and assembling centres.	
	6-7	Sampling and familiarization of commercially important groups.	
	8-11	Observations and experimental operations of selected fishing crafts and gears in inland / estuarine waters.	
	12-13	Maintenance of records on catch data.	
	14-16	Visit to Dept. of fisheries, lakes and reservoirs, net making yards.	
Suggested readings:-			
Ayyapan,2010, Handbook of Fisheries and Aquaculture, ICAR H R Singh & W S Lakra, Cold water Aquaculture and Fisheries, pp 1-36 Ed. Jhingran VG & Pathak V. 1987, FAO Tech paper on freshwater fisheries, Eco. & Manag. of Bheels in Asam- A case study. Jhingran VG 1991. Fish & Fisheries of India 3rd Edi. Hindustan Publishing House. Jhingran,V.G & Sehagal, K.L, 1978, Cold water Fisheries of India. Checklist of the Native freshwater fishes of India K Rema Devi, ZSI Jayaram, The Freshwater fishes of India. A Handbook Vol. I& II Sugunan VV 1997. Reservoir Fisheries of India, Blaber JM 1997. Fish & Fisheries of Tropical Estuaries, Chapman & Hall			
III	FRM 236 3 (2 + 1)	Physiology of Finfish and Shellfish	
	Theory		
	1-2	Water as a biological medium.	5
	3-5	Gas exchange; Circulation (finfish & shellfish).	15
	6-8	Excretion; Osmoregulation (finfish & shellfish).	
	9-12	Reproductive physiology (finfish & shellfish).	10
	13-14	Muscle physiology (finfish & shellfish).	5
	15-16	Sense organs (finfish & shellfish).	5
	17-18	Energy and nutrient status of food (finfish & shellfish).	10
	19-20	Nitrogen balance (finfish & shellfish).	5
	21-22	Standard and active metabolism (finfish & shellfish).	5
	23-24	Energy utilization (finfish & shellfish).	5
	25-28	Effect of environmental factors on physiology of fin and shellfishes.	5
	29-30	Stress related physiological changes (finfish & shellfish).	5
	31-32	Structure and functions of important endocrine glands (finfish & shellfish).	10
	Practical		
	1-4	Estimation of oxygen consumption (finfish & shellfish).	
	5-7	Osmoregulation (finfish & shellfish).	
	8-9	Ammonia excretion and carbon-dioxide output (finfish & shellfish).	
	11-12	Influence of temperature and salinity on metabolism (finfish & shellfish).	
	13-14	Haematology of fin and shellfishes (finfish & shellfish).	
	15-16	Histological techniques (finfish & shellfish).	
Suggested readings:-			

	<p>Evans, D. H., Claiborne, J. B. and Currie S. (2013) The Physiology of Fishes, Fourth Edition CRC Marine Biology Series.</p> <p>Brown, M. E. (Ed.). (2013). The Physiology of Fishes: Behavior. Academic Press.</p> <p>Khanna, S. S., & Singh, H. R. (2011). A text book of fish biology and fisheries. Narendra Publishing House.</p>		
		SEMESTER-IV	13+ 10 = 23
IV	FRM 247 1 (1 + 0)	Aquatic Mammals, Reptiles and Amphibians	
	Theory		
	1-3	Selected aquatic mammal, reptile, amphibian and birds species of India relevant to fisheries.	20
	4 -7	Taxonomic status, identification characters, distribution, abundance, habitat, exploitation,	20
	8-9	Threats and conservation.	20
	10-14	Biology of aquatic animals: Cetaceans (whales, dolphins, porpoises and narwal), Sirenia (manates and dugongs), Carnivora (seals, sea lions walruses, polar bear and otter), Sea turtles, tortoise, crocodiles, sea/ fresh water snakes and amphibians.	20
	15-16	IUCN criteria – Red list, Wild Life (Protection) Act.	20
	Suggested readings:-		
	<p>R. R. Reeves, B. S. Stewart, P. J. Clapham, J. A. Powell and P. Folkens, Guide to marine mammals of the world.</p> <p>Annalisa Berta, James L. Sumich, Kit M. Kovacs, Pieter Arend Folkens and Peter J. Adam, Marine Mammals Evolutionary Biology.</p> <p>H. Shrihai, Whales, Dolphins and Seals: A Field Guide to the Marine Mammals of the World.</p> <p>Anthony Martin, The illustrated encyclopedia of Whales and Dolphins.</p> <p>Dale W. Rice, Marine Mammals of the World.</p> <p>J.C. Daniel The Book of Indian Reptiles and Amphibians.</p>		
		SEMESTER-V	14+ 9 = 23
V	FRM 358 3 (2 + 1)	Marine Fisheries	
	Theory		
	1-4	Classification and definition of fishery zones and fishery resources of world.	13
	6-10	Overview of marine fisheries resources of the world and India, Maharashtra	14
	9-11	Methodology for estimation of marine fish landings in India	10
	12 -20	Major exploited marine fisheries of India, their developmental history and present status.	25
	21-24	Important pelagic - demersal fish, shellfish and seaweed resources of India.	13
	25-27	Traditional, motorized and mechanized fisheries according to major gears.	10
	28-30	Potential marine fishery resources of the India's EEZ.	9
	31-32	GIS and Remote sensing in marine capture fishery.	6
	Practical		
	1-4	Visit to fish landing centers	25
	5-7	Observation and analysis of catches by major crafts and gears.	19
	8-9	Methodology for estimation of marine fish landings in India	13
	10-12	Field collection of fishes, crustaceans, molluscs and seaweeds and record keeping of relevant data.	19
	13-14	Participation in fishing cruises.	12
	15-16	GIS and remote sensing in marine capture fishery.	13
	Suggested readings:-		

	Talwar P.K. and Kacker R.K. 2013 Commercial Sea fishes of India. Zoological Survey of India- Kolkata. 997 pp. Fischer, W and Bianchi G (eds) 1984. FAO species Identification sheets for fishery purposes. Western Indian Ocean (Fishing Area 51). Prepared and printed with the support of the Danish International Development Agency (DANIDA). Rome, Food and Agricultural Organization of the United Nations, vols. 1-6 page	
V	AHM 316 2 (1 + 1)	Fish Immunology
	Theory	
	1	Introduction, brief history to immunology. 5
	2	Types of immunity: Innate and adaptive immunity, cell mediated and humoral immunity, cells and organs of the immune system. 5
	3	Antigens – structure and types. epitopes, haptenes. Antibody – fine structure, classes with structure and functions. 5
	4	Antigenic determinants on immunoglobulins. 5
	5	MHC complex – types, structure, and functions. 5
	6	Antigen-antibody interactions- principle, antigen recognition by B-cells and T cells. 5
	7	Antigen-antibody reaction - Precipitin reactions, agglutination reactions. 5
	8	Microorganisms associated with fishes in health and disease. 5
	9	Defences mechanism in finfish and shellfish- specific and non-specific immune system. 10
	10	Pathogenicity and virulence. 5
	11	Sources of infection, transmission of disease producing organisms, portals of infection. 5
	11	Immunity to bacteria, fungi and parasites. 5
	12	Role of stress and host defence mechanism in disease development. 5
	13	Vaccines - types of vaccines – whole cell vaccine, purified macromolecules, recombinant –vector, DNA vaccines and multivalent subunit vaccines, modes of vaccine administration. 5
	14	Serological methods in disease diagnosis. 10
	15	Immunostimulants –types, mechanism of action, modes of administration. 10
	16	Immunoassays, immunodiffusion, ELISA, immunofluorescence, neutralization, radioimmunoassay, serotyping. 5
	Practical	
	1-3	Collection, separation and identification of fish leucocytes.
	4-8	Separation of blood plasma and serum. Differential counting - RBC and WBC by Haemocytometer.
	9-10	Study of different types of leukocytes and isolation of macrophages.
	11-14	Precipitin reactions - Agglutination test, immunogel diffusion, double immuno diffusion, radial immuno diffusion assay, ELISA.
	15-16	Methods of vaccine preparation and techniques of fish immunization.
	Suggested readings:-	
	Iwama & Nakanishi, (1996). The Fish Immune System: Organisms, Pathogens and Environment, (Eds.) Fish Physiology Vol. 15. Academic Press, California, USA. R.J. Roberts John Wiley and Sons, (2012). Fish Pathology (Fourth Edition) USA Zabriskie, (2009). Essential Clinical Immunology. (Ed.). Cambridge University Press, UK. Zaccone, Meseguer, Garcia-Ayala and Kapoor, (2009) Fish Defenses: Immunology (Vol.1). (Eds.). Science Publishers, USA.	
		SEMESTER-VI
		14+ 10 = 24
VI	FRM 369 3 (2 + 1)	Fish Population Dynamics and Stock Assessment

	Theory		
	1-2	The concept of population and unit stock.	5
	3-4	Biological structure of fisheries resource in space and time.	5
	5-6	Indicators of dynamics in a fishery resource.	5
	7	Characteristics of unit and mixed stock.	3
	8	Data requirements for stock assessment.	3
	9-10	Segregation of stocks. Principles of stock assessment.	5
	11-12	Population age structure.	5
	13	Theory of life tables.	3
	14-16	Von Bertalanffy growth parameters. Graphical models.	10
	17-18	Monte Carlo simulation model and ECOPATH model.	13
	19-22	Estimation of total fishing and natural mortality.	10
	23-25	The concept of yield, yield in number and yield in weight, yield per recruit, yield curve. Yield models. The concept of Maximum Sustainable Yield and Maximum Economic Yield.	4
	26	Biological symptoms of under-fishing and over-fishing. Growth over-fishing and recruitment over-fishing.	4
	27	Eumetric fishing.	4
	28	Open access fisheries. Fisheries regulations.	10
	29-30	CPUE. Trawl selection and gillnet selection.	5
	31-32	Analytical models of fish stocks.	6
	Practical		
	1-2	Study of length – weight relationship.	
	3	Segregation of stock using direct methods.	
	4-6	Study of analytical models: Beverton and Holt model. VBGF, Pauly's integrated methods, graphical models.	
	7-8	Estimation of Z, F and M. estimation of net selectivity coefficient.	
	9-11	Fitting of surplus production model: Schaeffer model, Fox model.	
	12-13	Study of yield isopleth diagrams.	
	14-16	Micro-computer packages ELEFAN, FISAT.	
	Suggested readings:-		
	<p>Devaraj M. 1983. Fish population Dynamics. Course manual. Central Institute of Fisheries Education, Mumbai. Bulletin No. 3 (10) 83. 94 pp.</p> <p>King, M. 1995. Fisheries biology, assessment and management. Fishing News Books. Oxford. 341 pp.</p> <p>Pauly, D. 1983. Some simple methods for the assessment of tropical fish stocks. FAO Fish Tech Paper No. 234. 52 pp.</p> <p>Sparre, P. and Venema, S.C. 1992. Introduction to tropical fish stock assessment Part – I Manual. FAO Fish Technical Paper No. 306.1, Rev. 1. Rome, FAO. 376 pp.</p>		

P.G. Course structure of discipline Fisheries Resources Management

M.F.Sc. (Fisheries Resource Management)

LIST OF COURSES

Major courses (20 credits)

Course Code	Semester	Course Title	Credits
FRM 501	I	Sustainable Fisheries Management	2+1
FRM 502	I	Fish Biodiversity and Conservation Biology	2+1
FRM 504	I	Fish Stock Assessment	2+1
FRM 503	II	Climate Change and Fisheries Resource	2+1
FRM 506	II	Reproductive Biology of Finfish and Shellfish	2+1
FRM 505	II	Trophodynamics in Aquatic Systems	2+1
FRM 507	II	Developmental Biology of Finfish and Shellfish	1+1
FRM 508	I	Modern Techniques in Fisheries	2+1
FRM 509	I	Bio Systematics of Aquatic Fauna	1+2
FRM 510	I	Inland Fisheries Resources Management	2+1
FRM 511	II	Marine Fisheries Resources Management	2+1
FRM 512	II	Advanced Fish Anatomy and Physiology	2+1
FRM 513	II	Fish Histology and Histochemistry	1+1
FRM 514	II	Field techniques in Fisheries Resource Management	0+2
			23+16=39

***Compulsory Courses**

Minor Courses (8 credits): Courses relevant for student's research work or necessary for building his/her overall competence from following disciplines can be also taken as minor courses.

1. Aquaculture, 2. Aquatic Environment management, 3. Fish Genetics and Breeding and
4. Aquatic Animal Health Management, 5. Fish Nutrition and Feed Technology

Supporting Courses (6 credits): The subject not related to the major subject. It could be any subject considered relevant for student's research work (such as Statistical Methods, Design of Experiments etc.) or necessary for building his/her overall competence can be taken. A few courses are suggested as under:

Course Code	Semester	Course Title	Credits
STAT 501	I	Mathematics for Applied Sciences	2+0
STAT 502	I	Statistical Methods for Applied Sciences	3+1
STAT 511	II	Experimental Designs	2+1
STAT 512	II	Basic Sampling Techniques	2+1
STAT 521	I	Applied Regression Analysis	2+1
STAT 522	II	Data Analysis Using Statistical Packages	2+1

MCA 501	I	Computers Fundamentals and Programming	2+1
MCA 502	II	Computer Organization and Architecture	2+0
MCA 511	I	Introduction to Communication Technologies, Computer Networking and Internet	1+1
MCA 512	II	Information Technology in Agriculture	1+1
BIOCHEM 501	I	Basic Biochemistry	3+1
BIOCHEM 505	II	Techniques in Biochemistry	2+2

Common Courses (Non Credit) (5 credits):

Course code	Semester	Course Title	Credits
PGS 501	I	Library and Information Services	0+1
PGS 502	I	Technical Writing and Communication Skills	0+1
PGS 503	II	Intellectual Property and its Management in Agriculture	1+0
PGS 504	I	Basic Concepts in Laboratory Techniques	0+1
PGS 505	II	Agricultural Research, Research Ethics and Rural Development Programmes	1+0

Some of these courses are already in the form of e-courses/MOOCs. The students may be allowed to register these courses/similar courses on these aspects, if available online on SWAYAM or any other platforms. If a student has already completed any of these courses during UG, he/she may be permitted to register for other related courses with the prior approval of the HoD/BoS.

Master's Seminar (1 credit):

Course Code	Semester	Course Title	Credits
FRM 591	IV	Master's Seminar	0+1

Master's Thesis Research (30 credits):

Course Code	Semester	Course Title	Credits
FRM 599	III	Master's Research	0+15
FRM 599	IV	Master's Research	0+15
		Masters' Research	0+ 30

Ph.D. (Fisheries Resource Management) courses Structure

LIST OF COURSES

Major Courses (12 credits):

Course Code	Semester	Course Title	Credits
FRM 601	I	Fisheries Resource Conservation and Restoration Biology	2+1
FRM 602	I	Assessment of Aquatic Biodiversity and Ecosystem	2+1
FRM 603	I	Functional Physiology of Fishes	2+1
FRM 604	II	GIS Use in Fisheries resources	2+1
FRM 605	II	Fisheries Legislations, Governance and Treaties	1+1
FRM 606	II	Software Applications in Fish Stock Assessment	1+1
FRM 607	I	Coral reef management	1+1
Total			11+7=18

Minor Disciplines (6 credits): Courses relevant for student's research work or necessary for building his/her overall competence from following disciplines can also be taken as minor courses.

1. Aquaculture, 2. Aquatic Environment management, 3. Fish Genetics and Breeding and 4. Aquatic Animal Health Management, 5. Fish Nutrition and Feed Technology

Supporting Courses (5 credits): The subject not related to the major subject. It could be any subject considered relevant for student's research work (such as Statistical Methods, Design of Experiments etc.) or necessary for building his/her overall competence can be taken. A few courses are suggested as under:

Course Code	Semester	Course Title	Credits
FST 601	I	Advanced Statistical Methods	2+1
FST 602	II	Software for Fisheries Data Analysis and Management	0+2

Doctoral Seminar (2 credits):

Course Code	Semester	Course Title	Credits
FRM 691	III	Doctoral Seminar	0+1
FRM 692	IV	Doctoral Seminar	0+1

Doctoral Research (75 credits):

Course Code	Semester	Course Title	Credits
FRM 699	II to VI	Doctoral Research	0+75

Course Contents
M.F.Sc. (Fisheries Resource Management)

FRM 501	SUSTAINABLE FISHERIES MANAGEMENT	2+1
Objectives	<p>To understand the major inland and marine fisheries resources of the world and India</p> <p>To discuss the major sustainability issues in the inland and marine fisheries sectors</p> <p>To understand the ways and means to resolve the issues for sustainable fisheries resource management</p>	
Theory		
Unit I	Inland fisheries: Major inland fisheries resource of the world-India-Overview-State of the fisheries- fishing gears-and crafts- catch composition	
Unit II	Marine fisheries: Major marine fisheries resources of the world and India-Overview- State of the fisheries -fishing gears -catch composition-pelagic, demersal, oceanic, deep sea	
Unit III	Sustainability issues in fisheries: ghost fishing- Overexploitation, overcapacity, pollution, habitat degradation/ biodiversity loss, Damming of rivers, Interlinking of rivers ,Environmental flows; fishing conflicts-Exotics; trans-boundary issues, IUU fishing, Interlinking of rivers-Climate change, By catch and discards.	
Unit IV	Sustainable fishing: Components of sustainability, Indicators and goals of sustainability, Eco-friendly fishing, Ecosystem Based Fisheries Management-resilient fishery system	
Unit V	Principle of fisheries management- Management approaches: By catch reduction-Rebuilding fishery, Rebuilding stock, co- management- right based fishing- input control (fishing efforts, mesh regulations, fishing ban, licensing, capital investments, Etc)-output control(catch quotas, minimum legal size, etc)- fishery reserve-technical measures, Spawning aggregates; trade agreement- market- based instruments; access right- catch sharing-balanced fishing- subsidy-certification and traceability-sustainable management approach in lake, reservoir and bheels.	
Unit VI	Responsible fishing practices: Precautionary management - Fisheries Co-management: Right based fishing- catch sharing access right- -balanced fishing. Technical Guidelines of CCRF for responsible fishing; National and International treaties (National policy on marine fisheries-2017; National policy on inland fisheries-2019; MFRA's; UNCLOS; UNFSA; IOTC)	
Practical	Capture fisheries: observation at lakes, reservoirs, river stretches, and marine landing centres. Species landings analysis. Interaction with managers Co-operative societies and stakeholders Fleet capacity assessment. visit to fishery reserves to understand management. Field survey and observation of fisheries issues. Development of management plan.	

Suggested Readings	<p>Bal DV & Rao KV. 1990. Marine Fishes of India. 1st Revised Ed. Tata McGraw Hill.</p> <p>Chandra P. 2007. Fishery Conservation, Management and Development. SBS Publ. Dholakia AD. 2004.</p> <p>Moyle PB & Joseph JC Jr. 2000. Fishes – An Introduction to Ichthyology. 4th Ed. Prentice Hall.</p> <p>Peter BM & Joseph JC. Jr. 2000. Fishes- An Introduction to Ichthyology. 4th Ed. Prentice Hall.</p> <p>Samuel CT. 1968. Marine Fisheries in India. Narendra Publ. House.</p> <p>Yadav BN. 1997. Fish and Fisheries. 2nd Ed. Daya Publ. House.</p>
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FRM 502	FISH BIODIVERSITY AND CONSERVATION BIOLOGY	2+1
Objectives	<p>To appreciate the biodiversity of various major aquatic fauna and flora</p> <p>To understand the major threats to this aquatic biodiversity</p> <p>To develop management strategies for the conservation of aquatic biodiversity</p>	
Theory		
Unit I	Fish diversity: Freshwater fish diversity- Marine fish diversity- Quantification and importance of biological diversity- abundance-distribution.	
Unit II	Species concept for conservation related decisions: Unique species-umbrella species-flagship species, keystone species, state fish concept, Endangered species-extinction-recovery-CITES - NBA- Migratory stock-Essential Habitat-EBSA.	
Unit III	Biodiversity conservation methods: IUCN criteria - Red List, Marine Protected Areas, Sanctuaries and Biosphere reserves.	
	Establishment of National marine parks, in situ and ex situ conservation, participatory approach- Conservation value index – criteria – medicinal and biological, IBI –stock resilience-recovery. Wildlife protection act, Biodiversity Act, International treaties and conventions (CITES, CMS, RAMSAR Convention).	
Unit IV	Impacts of anthropogenic intervention on fisheries biodiversity: Exotic species, Damming of rivers, construction of shore protection walls, micro hydal power stations, oil rigs.	
Unit V	Aquatic biodiversity: threats-Overexploitation, habitat reclamation, pollution, habitation, planning and management, tools for conservation, participatory approach -Impact of climate change on the ecosystem biodiversity, health and productivity	

Unit VI	Conservation biology of biodiversity: Concept of hotspots- Ecological integrity: minimum population sizes, inbreeding depression, genetic tolerance of extreme conditions. Restoration of populations at risk of extinction. Conservation –management of invasive species- Economic valuation of biodiversity and ecosystems
Practical	Identification of scheduled aquatic organisms and exotic species. Predators of endangered animals. Visit to various aquatic ecosystem for recording the biodiversity. Conservation strategies (case studies). Calculation of trophic levels, Biodiversity indices-IBI. Conservation value Index. Presentation of field study.
Suggested Readings	<p>Brian G. 1992. Global Biodiversity - Status of the Earth's Living Resources. Chapman & Hall.</p> <p>Denton TE. 1973. Fish Chromosome Methodology. Charles Thomas Publ.</p> <p>Elliott A. Norse (Ed.) 1993. Global marine Biological Diversity. Inland press, Washington, D.C.383p.</p> <p>Gunderson DR. 1993. Surveys of Fisheries Resources. John Wiley & Sons. New York. 248 p.</p> <p>Khanna DR, Chopra AK & Prasad G. 2005. Aquatic Biodiversity in India. Daya Publ. House.</p> <p>Kumar U & Asija M. J. 2000. Biodiversity Principles and Conservation. Agrobios.</p> <p>Lakra WS, Abidi R, Singh AK, Sood N, Rathore G & Swaminathan TR. 2000. Fish Introductions and Quarantine: Indian Perspective. National Bureau of Fish Genetic Resources (NBFGR), Lucknow.</p> <p>Lamshead PJD, Paterson GLJ & Gage JD. 1997. Biodiversity Professional. Version 2. National History Museum and the Scottish Association of Marine Science.</p> <p>Magurran AE. 1988. Ecological Diversity and its Measurement. Taylor & Francis.</p> <p>Mahanta PC & Tyagi LK. 2003. Participatory Approach for Fish Biodiversity Conservation in North East India. National Bureau of Fish Genetic Resources (NBFGR), Lucknow.</p> <p>Ponniah AG & Gopalakrishnan A. (Eds.). 2000. Endemic Fish Diversity of Western Ghats. National Bureau of Fish Genetic Resources (NBFGR), Lucknow.</p> <p>Zoological Survey of India. 2007. National Symposium on Conservation and Valuation of Marine Biodiversity.</p>

FRM 503	CLIMATE CHANGE AND FISHERIES RESOURCE	2+1
Objectives	<p>To become familiar with causes and effects of climate change</p> <p>To understand the models and methods available for estimating climate change effects</p> <p>To develop strategies for the mitigation of climate change effects for the management of fisheries resources</p>	
Theory		

Unit I	Introduction to climate science: Climate & biosphere, climatic forcing factors, history of earth's climate, Climate change: the physical basis in marine and freshwater systems; anthropogenic activities, greenhouse gases; Role of oceans; diagnosing climate change- Scenarios
Unit II	Climate change threats to fisheries resource: temperature, freshwater precipitation and sea level rise- Climate-induced degradation and loss of critical fish habitats. –Resilience - Tolerance limit-Temperature, pH and Salinity- Global warming and ocean acidification on fish early life stages.
Unit III	Climate change: Interaction between biodiversity - effect on aquatic population –critical habitats-marine -freshwater-estuarine-high seas- endemic resources- Indicators of climate change - Climate change and invasive species.
Unit IV	Impact of Climate change on fish: On fish biology, reproduction and life stages, distribution and abundance- migration patterns-fish physiology-disease prevalence. Adaptation strategies of fishes towards climate change.
Unit V	Models on climate change and capture fisheries: trophic dynamics model- Methods for estimating effects of climate change on fishery resources-Long term monitoring- Survey on effects of climate change on fisheries resources - Developing vulnerability index.
Unit VI	Policies and strategies on climate change: Impact of climate change on livelihood, Mitigation (emission reduction, life cycle assessment, carbon sequestration, improved governance) and adaptation strategies (resilience, vulnerability and risk assessment, institutional mechanisms) to climate change- Policy on climate change - IPCC, UNFCCC - Harvesting strategies - fishing right- Fishery resource management- key indicator species monitoring.
Practical	Fish production trend analysis- India- global. Thermal effect on fish biology and reproduction. Climate change effect on fish early life stages- fish physiology. Biodiversity- Threshold limits-temperature-pH and Salinity. Generation of fish distributional map. Group discussion on climate change, impact and mitigation strategies. Presentation of case studies.
Suggested Readings	Amielle DeWan, Natalie Dubois, Kathleen Theoharides, Judith Boshoven, 2010. Understanding the impacts of climate change on fish and wildlife in North Carolina- A review of climate change science, impacts, and planning options. for sensitive species and habitats. Defenders of Wildlife Washington D.C accessed through http://www.defenders.org 209 p. ACIA. 2004. Impacts of a Warming Arctic. Arctic Climate Impact Assessment (ACIA). Cambridge University Press, Cambridge, UK. 139 p. Crance .J.H.. 1987. Guidelines for using the Delphi technique to develop habitat suitability index curves. Biological Report 82 (10.134), U.S. Fish and Wildlife Service, Washington, Crul R.C.M. (1992) Models for estimating potential fish yields of African inland waters. CIFA Occasional Paper No. 16, Food and Agriculture Organization of the United Nations, Rome.

	<p>David M. Checkley, Jurgen Alheit, Yoshioki Oozeki and Claude Roy (eds.), 2009 .Climate Change and Small Pelagic Fish Cambridge University Press. ISBN 978-0-521-88482-2. 355.p.</p> <p>Lekan Oyebande, Dr. Abou Amani, Dr. G. Mahe, Dr. Isabelle NIANG, 2002. Climate Change, Water and Wetlands in West Africa: Building linkages for their Integrated Management , IUCN- BRAO WORKING PAPER .69. P.</p> <p>McGinn, N. A., editor. 2002. Fisheries in a changing climate. American Fisheries Society Symposium 32, Bethesda, MD.</p> <p>Nelitz, M., K. Wieckowski, M. Porter, K. Bryan, F. Poulsen, and D. Carr. 2010. Evaluating the vulnerability of freshwater fish habitats to climate change and identifying regional adaptation strategies in the Cariboo-Chilcotin. Report prepared for Fraser Salmon and Watersheds Program by ESSA Technologies Ltd. pp.51.</p> <p>Oehlert, Gary W. 2000. A first course in design and analysis of experiments. 1st Edition. WH Freeman, New York, NY.</p> <p>Parnel, M.M, R.L. Emmett, and R.D. Brodeur. 2008. Ichthyoplankton community in the Columbia River Plume off Oregon: effects of fluctuating oceanographic conditions. Fish. Bull. 106:161-173.</p>
	<p>Robert Buchsbaum, Judith Pederson, and William E. Robinson (eds.) 2005. The Decline of Fisheries Resources in New England: Evaluating the Impact of Overfishing, Contamination, and Habitat Degradation., MIT Sea Grant College Program, Massachusetts .175 p.</p> <p>Sinclair, M. 1988. Marine Populations: an Essay on Population Regulation and Speciation. University of Washington Press, Seattle</p> <p>Tasker, M. (Ed.) 2008. The effects of climate change on the distribution and abundance of marine species in the OSPAR maritime area. ICES Cooperative Research Report, 293. 45p.</p> <p>Thomann R, Mueller J (1987) Principles of surface water quality modeling and control. Harper and Row, Inc, New York</p> <p>Vivekanandan, E. 2011. Climate Change and Indian Marine Fisheries. CMFRI Special Publication No. 105, CMFRI, Kochi.</p> <p>Janardhanan Sundaresan, K.M.Santosh, Andrea Deri, Rob Roggema and Ramesh Singh., eds. 2013. Geospatial Technologies and Climate Change. 299p.</p> <p>Waggoner PE (ed) Climate change and U.S. water resources. John Wiley and Sons, New York,</p> <p>Weisberg, S. 2005. Applied linear regression. 3rd edition. John Wiley & Sons, Inc., Hoboken, NJ.</p>

FRM 504	FISH STOCK ASSESSMENT	2+1
Objectives	<p>To understand the stock concept and principles of fisheries management To Understand the application of various models and their applications in fisheries management.</p> <p>To get an idea of the interaction of fish population in the ecosystem.</p>	

Theory	
Unit I	Concept of stock and fish stock assessment: Distribution and types of stock - unit stock-mixed stock- straddling stock; characterization of stock (life history traits, truss network, environmental signals, otolith shape; genetic analyses, applied marks); Principle and general procedure of fish stock assessment; features of tropical and temperate fish stocks; Role of fish stock assessment in fisheries management.
Unit II	Sampling and measurements for fish stock assessment: Data requirement; Methods of sampling commercial catch, sampling design and fish measurements; Assessment of fishery under data poor conditions; survey methods for inland fisheries.
Unit III	Concept of growth and mortality: Principles of growth; growth parameters- estimation of growth parameters employing hard parts and size frequency, separation of cohorts. Mortality -Decay curve; types of mortality; Estimation of total, natural and fishing mortality rates.
Unit IV	Recruitment and gear selectivity: Timing and size of recruitment; factors influencing recruitment; principle and estimation of gear selectivity – trawl net and gill net selectivity; Eumetric fishing; Stock recruitment relationship– Cushing- Rickers- Beverton and Holt models.
Unit V	Fish stock assessment models: Analytical models: Cohort dynamics and life history; Virtual population analysis; Prediction models (Thompson and Bell model; Yield per recruit model and Relative Yield per Recruit model); Prey-predatory model; Surplus production models / Holistic models: Schaefer's model, Fox model, Swept area method, Stochastic model. Estimation of technical reference point MSY and other yield base reference point; economic and social reference points. Bio-economic modelling. Economic models - MEY. Swept area method - Box model- Bayesian Stochastic models. Multispecies models
Unit VI	Trophic models: Ecosystem based models– principles, applications; productivity models; Ecopath with Ecosim.
Practical	Cohort analysis; Characterization of fish stock, 11-measurements; truss network analysis, otolith shape estimation of growth and mortality parameters (hard parts/length based/age based). Gear selectivity, Stock recruitment relationship; Analytical models – VPA, Thompson and Bell model. Beverton's Yield per recruit and Relative yield per recruit model. Holistic models - Schaefer and Fox models; Swept area method, MSY. Use of FiSAT, LFDA, CEDA, YIELD. Presentation of case studies on use of ecosystem models.
Suggested Readings	Beverton R.J.H. and Holt. S. J., 1957. On the dynamics of exploited fish population. Fish. Invest. Ser. II, Vol. 19: 533p. Min. of Agriculture and Fisheries, London. Callucci, V.G., Saila, S.B., Gustafson D.J. and Rothschild, B.J., 1996. Stock Assessment. Quantitative methods and applications for small scale fisheries. Lewis publishers. Boca Raton, P. 527.

	<p>Devaraj M. 1983. Fish Population dynamics : a course manual, CIFE Bulletin 3 (10):98p</p> <p>Gulland, J.A. 1977. Fish population dynamics. John Wiley and sons. Chichester. P. 422.</p> <p>Gulland, J.A. 1992. A review of length based approaches to assessing fish stocks. FAO technical paper. 323. p.100.</p> <p>Hilborn, R and C.J. Walters, 1992. Quantitative Fisheries Stock Assessment – Choice, Dynamics and Uncertainty. Pub. Chapman and Hall. 570p.</p> <p>King, M., 1995. Fisheries Biology, Assessment and Management. Pub. Fishing News Books. 341p.</p> <p>Manual. FAO. Fisheries Technical paper No: 301. FAO Rome. p407.</p>
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FRM 505	TROPHODYNAMICS IN AQUATIC SYSTEMS	2+1
Objectives	<p>To understand the various methods of gut content analysis and various feeding indices</p> <p>To understand the relationship within a community, energy flow</p> <p>To develop linkages between biota and environment</p>	
Theory		
Unit I	Food and feeding adaptations: Food and feeding habits of different types of finfish and shellfishes -Morphological and anatomical adaptation for feeding; feeding behaviour-Ontogenic changes in food and feeding.	
Unit II	Digestion - Food digestion - energetics- food partitioning- larval feed-gut development.	
Unit III	Food web- food web - food web in nearshore reef, seagrass and unvegetated ecosystems - biomarkers - stable isotopes and fatty acids markers	
UNIT IV	Prey predator interaction - Prey density - predator density--prey predatory interaction forage theory--species succession - food availability - fishing effect on prey and predator	
Unit V	Trophodynamics: Concept of trophodynamics-methods in food and feeding analysis-diet analysis -diet breath- diet overlapping indices-Energy flow and trophic indices and modelling- calculation of trophic level.	
Unit VI	Application of information on trophodynamics in fisheries management: Trophodynamic indicators- Ecopath with Ecosim model, SEAPODYM model.	
Practical	Morphological and anatomical adaptations in finfishes and shellfishes with different feeding habits. Analysis of gut contents. Gastro somatic Index. Use of indices in feeding, digestion and food consumption rates of fishes. Calculation of trophic levels- Mean trophic level. Comparison of mean trophic level between gears-season-space. Analysis of diet breath and diet overlap. Case studies using available data sets.	

Suggested Readings	<p>Bone, Q. N.B.Marshall and J.H.S.Blaxter, 1995. Biology of Fishes (2nd edition) Black ie Academic and professional, New york. 332 p.</p> <p>Carl E. Bond. 1979. Biology of Fishes (2nd edition). Saunders college publishing Harcourt Brace college publishers, New york. 750 p.</p> <p>Khanna, S.S.1993. An introduction to fishes. Central Book of Depo, Allahabad, 530 p.</p> <p>Venkataramanujam, K. and N. Ramanathan 1994. Manual of FinfishBiology. Oxford and IBH publishing Co. pvt. Ltd 1108.</p> <p>D' Abramo, L. R., Conklin, D. E. and Akiyama. D. M. 1977. Crustacean Nutritional : Advances in Aquaculture Vol. 6. World Aquaculture Society, Baton Roughe, L. A. De Silva, S. S. and Anderson, T. A. 1995. Fish Nutrition in Aquaculture. Chapman and Hall Aquaculture Series, London.</p> <p>Guillame, J., Kaushik, S., Berqot, P. and Metallier, R. 2001. Nutrition and Feeding of Fish and Crustaceans. Springer Praxis Publishing, Chichester, U.K.</p> <p>Halver, J. E. and Hardy, R. W. 2002. Fish Nutrition. Academic Press,London.</p> <p>Lovell, R. T. 1998. Nutrition and Feeding of Fishes. Kluwer Academic Publishers.</p> <p>New, M. B. 1987. Feed and Feeding of Fish and Shrimp. A Manual on the Preparation and Preservation of Compound Feeds for Shrimp and Fish in Aquaculture. ADCP/REP/87/26.F.A.O., Rome</p> <p>NRC (National Research Council). 2011. Nutrient Requirements of Fish and crustaceans. National Academy Press, Washington.</p> <p>Boyd, C.E., 2015. Water quality: an introduction. Springer.</p> <p>Kaushik, S.J. 1998.Nutritional bioenergetics & estimation of waste production in non-salmonids. Aquat living resour 11(4):211-217</p>
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FRM 506	REPRODUCTIVE BIOLOGY OF FINFISH AND SHELLFISH	2+1
Objective	To familiarise with the reproductive system and physiology of reproduction of teleost, elasmobranch, shrimps and molluscs	
Unit I	Fish reproduction: Types– gonads -sexual differentiation, Reproductive biology: Gonado Somatic Index, fecundity, Length at first maturity-breeding migration-Environmental influence of breeding cycle.	
Unit II	Male reproductive system of finfish and shellfish: Endocrinology-spermatogenesis-sperm morphology.	
Unit III	Female reproductive system of finfish and shellfish: Endocrinology- Oogenesis- Ovulation- Atresia- vitellogenesis.	
Unit IV	Physiological control of reproduction in finfish: Fish reproduction –fish-hormone- Hormone Dynamics- Maturation and spawning, Hormones in spermatogenesis, oogenesis, yolk formation, mechanism of sex reversal; Pheromone. hormone based induced reproduction.	

Unit V	Physiological control of reproduction in crustaceans (shrimp, crab and lobsters): Maturation and spawning, spermatogenesis, oogenesis, yolk formation, mechanism of sex reversal- eye stalk ablation.
Unit VI	Physiological control of reproduction in molluscs: Maturation and spawning, spermatogenesis, oogenesis, yolk formation, mechanism of sex reversal – sex Control; Early Embryonic Development Maturity cycle and hormone
Practical	Sexual dimorphism. Study of reproductive organs in finfish and shellfish by dissection. Maturity stage observation. Length at maturity estimation- intra-ovarian periodicity. Dissection of reproductive glands; fish sperm quality analysis – morphology, quantification and motility; Egg quality analysis – morphology, fecundity estimation; Histological techniques- study gonadal maturity stages; Identification of moult stages
Suggested Readings	<p>Adiyodi KG & Adiyodi RG. 1971. Endocrine Control of Reproduction in Decapod Crustacea. Biology Reviews. Agarwal NK. 2008. Fish Reproduction. APH Publ.</p> <p>Bell TA & Lightner TA. 1988. A Handbook of Normal Penaeid Shrimp Histology. World Aquaculture Society.</p> <p>Ghosh R. 2007. Fish Genetics and Endocrinology. Swastik Publ. & Distr.</p> <p>Hoar WS, Randall DJ & Donaldson EM. 1983. Fish Physiology. Vol. IX. Academic Press.</p> <p>Maria RJ, Augustine A & Kapoor BG. 2008. Fish Reproduction. Science. Publ.</p> <p>Matty AJ. 1985. Fish Endocrinology. Croom Helm.</p> <p>Mente E. 2003. Nutrition, Physiology and Metabolism in Crustaceans. Science Publ.</p> <p>Nikolsky GV. 2008. The Ecology of Fishes. Academic Press.</p> <p>Thomas PC, Rath SC & Mohapatra KD. 2003. Breeding and Seed Production of Finfish and Shellfish. Daya Publ. House.</p> <p>Adiyodi K.G , Reproductive Biology of Invertebrates: Vol-X P.B Prog in Developmental Endocrinology, Narendra Publishing House Publishers & Distributors</p> <p>Adiyodi K.G. Reproductive Biology of Invertebrates: Vol-X P-A Prog in Dev. Endocrinology Narendra Publishing House Publishers & Distributors.</p> <p>Agarwal, N.K. 1996. Fish reproduction APH publishing corporation, New Delhi. 155p.</p> <p>Barrington, E.J.W. 1981. Invertebrate structure and Function (2nd Edition). The English Language Book society and Nelson, Great Britain. 765p.</p> <p>Bone, Q. N.B. Marshall and J.H.S. Blaxter, 1995. Biology of Fishes (2nd edition) Black ie Academic and professional, New york. 332 p.</p> <p>Carl E. Bond. 1979. Biology of Fishes (2nd edition). Saunders college publishing Harcourt Brace college publishers, New york. 750 p.</p> <p>Hoar, W.S. and D.J Randall (Ed.) 1969. Fish physiology vol.III Academic press, New york. 415p.</p> <p>Khanna, S.S. 1993. An introduction to fishes. Central Book of Depo, Allahabad, 530 p.</p> <p>Malcolm Jobling 1995. Environmental Biology of Fishes, Chapman and Hall</p>

	<p>London. 455 p.</p> <p>Maria J. Rocha, Augustine Arukwe and B.G. Kapoor, 2006. Fish Reproduction Pb.Science Publishers, Enfield, NH</p> <p>Bernier, N, Kraak, GVD. Farrell, A.P. and Brauner, C.J. (2009). Fish Physiology: Fish Neuroendocrinology. Elsevier. 529 pp.</p> <p>Thomas, P.C. Rath, S.C. and Mahapatra, K.D. 2017. Breeding and Seed Production of Finfish and Shellfish. DayaPublsiing house. 402 pp.</p> <p>Saxena, A.B.1996. Life of crustaceans. Recent advance inentomology series –10.Onmol publications pvt. Ltd. New Delhi. 380p.</p> <p>23. Venkataramanujam, K. and N. Ramanathan 1994. Manual of Finfish Biology. Oxford and IBH publishing Co. pvt. Ltd 1108.</p>
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FRM 507	DEVELOPMENTAL BIOLOGY OF FINFISH AND SHELLFISH	1+1
Objective	To impart knowledge on the collection and identification of egg and larvae of commercially important finfish and shellfish To understand developmental biology of aquatic organisms.	
Theory		
Unit I	Fish eggs and larvae: Morphology and identification of eggs and larvae of commercially important finfishes, crustaceans, molluscs and echinoderms-morphometry.	
Unit II	Methods in Fish eggs and larval study: Quantitative sampling of fish eggs and larvae; spatial and temporal distribution, dispersion of eggs and larvae, effect of environmental parameters on eggs and larvae.	
Unit III	Eggs and larval dynamics: Reproductive cycle in fish- Spawning – environmental cues- recruitment assessment-Natural food of commercially important finfish and shellfish larvae from egg to adult.	
Unit: IV	Larval development: Developmental biology of fish- shellfish-sea urchin-stages of development- cell fate & commitment, embryonic induction, differentiation-- Organogenesis- Morphogenetic movements,	
Practical	Identification of eggs and larvae commercially important species of crustacean and molluscan. Morphometry of eggs and larvae of finfishes, identification keys. Quantitative sampling- finfish and shellfish larvae; food and feeding habits of larval stages of finfish and shellfishes.	

Suggested Readings	<p>Barrington EJW. 1981. Invertebrate Structure and Function. 2ndEd. The English Language Book Society & Nelson.</p> <p>Diwan AP & Dhakad NK. 2004. Embryology of Fishes. Recent Advances in Embryology Series-1. Anmol Publ.</p> <p>Ede DA. 1978. An Introduction to Developmental Biology. Blackie.</p> <p>Hoar WS & Randall J. (Ed.). 1988. Fish Physiology. Vol XI. The Physiology of Developing Fish. Part B. Viviparity and Post hatching Juveniles. Academic Press.</p> <p>Jobling M. 1995. Environmental Biology of Fishes. Chapman & Hall.</p> <p>Khan SA, Raffi SM & Lyla PS. 2003. Larvae of Decapod Crustaceans. Centre of Advanced Study in Marine Biology, Parangipettai, TamilNadu.</p> <p>Silas EG. 1983. Development of Penaeid Prawns. CMFRI Bull. No.28.</p> <p>Werner A. Muller, 1996. Developmental Biology, Springer. 328p.</p>
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FRM 508	MODERN TECHNIQUES IN FISHERIES BIOLOGY	2+1
Objectives	To be aware of the modern / including molecular techniques that can be applied in fisheries biology	
Theory		
Unit I	Introduction: Advances in molecular technology – DNA extraction and PCR- quality and size of DNA- Sequencing-RNA extraction	
Unit II	Electrophoresis: Principles – types of electrophoresis- identification of fish using agarose gel electrophoresis- SDS-Page- Staining protein gels- Digital electrophoresis analysis- Other electrophoresis techniques.	
Unit III	PCR: Principle; PCR as a rapid detection method- Quantitative real-time PCR- Multiplex PCR- Nested PCR -Developments in molecular genetic techniques in fisheries.	
Unit IV	Molecular genetic techniques in fisheries: Metagenomics and meta-transcriptomics- molecular techniques in population studies.	
Unit V	Molecular methods in taxonomy: Cytological and Molecular Systematics and DNA Barcoding-barcode analysis.	
Unit VI	Fish genetic markers and their applications in fisheries: Use of microarrays & RT-PCR- D-loop polymorphism analysis -Single Nucleotide Polymorphism -Restriction Length polymorphism analysis.	
Practical	Molecular laboratory safety issues- Extraction of DNA/ RNA. Barcode generation and analysis. Phylogenetic tree construction using barcode. Allozyme variation. Protein assay -2D gel electrophoresis.	
Suggested reading	Carvalho Gary R. Molecular Genetics in Fisheries Cocolin, L Rajkovic, A., Rantsiou, K., Uyttendaele M. 2011. The challenge of merging food safety diagnostics needs with Real-time PCR platforms. Trends in Food Science & Technology. 1-9	

Sambrook, J., Fritsch, E.F., Maniatis. Molecular Cloning, A laboratory Manual. Third edition. 2001. Cold SpringHarbor Laboratory, USA

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Harvey Lodish and Arnold Berk, Chris A. Kaiser, and Monty Krieger; 2008. Molecular cell biology Ed. 6th; W H Freeman and Company; New York;

Wilson, K. and Walker, J. (eds.). PRACTICAL BIOCHEMISTRY – PRINCIPLES AND TECHNIQUES: Cambridge University Press, UK.

Brown TA. (Ed.). 2002. Essential Molecular Biology. Vols. I, II. 2ndEd. Oxford University Press.

Cooksey K. 1997. Molecular Approaches to the Study of theOceans. Chapman & Hall.

FAO. 2000. DNA Based Molecular Diagnostic Techniques.

Kocher TD & Carol AS. (Ed.). 1997. Molecular Systematics ofFishes. Academic Press.

Le Gal Y & Halvorson HO. 1998. New Development in Marine Biotechnology. Plenum Press.

Mayer E. 1977. Principle of Systematic Zoology. Tata McGraw Hill.

Ponniah AG & George J. 1998. Fish Chromosome Atlas. National Bureau of Fish Genetic Resources (NBFGR), Lucknow.

Whitmore DH. 1990. Electrophoretic and Isoelectric FocusingTechniques in Fisheries Management. CRC Press.

FRM 509	BIO SYSTEMATICS OF AQUATIC FAUNA	1+2
Objective	To acquire in-depth knowledge on the basics and recent developments in systematics and taxonomy of aquatic fauna	
Theory		
Unit I	Principles of taxonomy: Systematics, Taxonomy and Classification; Importance of taxonomy, Describing and naming of a new species, International Code of Zoological Nomenclature, and its amendments and rules of Binomial Nomenclature; Zoo Bank and its policies. Morphology, morphometric, meristic, osteology and soft anatomical characters.	
Unit II	Classification of Commercially important finfish: Classification of modern fishes up to order and family levels - Elasmobranchii (Cartilaginous fishes) and Actinopterygii (bony fishes).	
Unit III	Classification of Commercially important shellfish: Classification of commercially important invertebrate up to family level: Arthropoda (Prawns, Shrimps, Lobsters and Crabs); Mollusca (Gastropods, Bivalves, Cephalopods and Scaphopods); Echinodermata (Sea Cucumbers), Preparations of dichotomous key.	

Unit IV	Methods in taxonomy: Phylogeny and Zoo geography, Modern tools of taxonomy: Cytotaxonomy, Basics of biochemical taxonomy (Electrophoretic studies of muscle myogen, eye-lens protein, enzyme pattern and serology), PCR based methods and DNA finger printing, mitogene in fish identification. Identification of fish through auto-image processing.
Practical	Collections and preparation of field data; preservation techniques of specimens: Morphology, Graphical representation and statistical analysis of meristic, morphometric, osteological and soft anatomical characters; Key Pattern – dichotomous key – type of keys – dichotomous, bracket, indented, branching, pictorial, and computer keys; Protocols followed for describing of a new species. use of distribution maps; curation and sorting protocols. Visit to freshwater, brackishwater and marine waters (markets; landing centres) of the locality and inventorying of commercially important fishes, Mollusca, Crustacea, Echinodermata (diagnostic characters of the orders, families and species). Modern taxonomical tools. Cytotaxonomy: Karyotyping – preparation and identification of chromosomes. Electrophoresis studies (muscle myogen, eye-lens protein, enzyme pattern and serology), Molecular markers–PCR, RAPD, RFLP, Microsatellites, mini satellites and Mitochondrial DNA and their application in fish phylogenetic studies; Barcoding
Suggested Readings	Apte, D., (1998). The book of Indian shells. Oxford University Press. Calcutta, Chennai, Delhi, Mumbai. p 115. Barman, R. P. and S. S. Mishra. 2012, Nemipteridae, Polynemidae, Mullidae (Separate compilation for each family). Barman, R. P., S. S. Mishra, S. Kar, P. Mukherjee and S. C. Saren. 2012. Marine and estuarine fishes of Maharashtra. Zool. Surv. India, Fauna of Maharashtra, state fauna series, 20(part 1): 369-480, 2012.
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Marine species identification portal for crustaceans (crabs and prawns etc).

Mayr, E., 1977. Principles of systematic zoology. Tata Mc Graw Hill Publishing Co. Ltd. New Delhi, p. 428.

Michael M. Cox and David L. Nelson. 2010. Leninger Principles of Biochemistry, Fifth Edition. W.H. Freeman and company, New York.

Moyle, P. B. and J. R., Cech., 1996. Fishes – An Introduction to Ichthyology. Prentice Hall Inc. N. Jersey, 594p.

Munro, I.S.R., 2000. The marine and freshwater fishes of Ceylon. Narendra Publishing house, New Delhi. 351 p.

Nelson J.S., 2006. Fishes of the world, IVth edition, John Weily& sons.

Ponniah A.G. and George John, 1998. Fish Chromosome Atlas. National Bureau of Fish Genetic Resources (NBFGR), Lucknow publication.

Poutiers, J. E. 1998. Bivalves; Gastropods. In: K. E. Carpenter, V H. Niem (eds.), FAO species identification guide for fisheries purposes. The living marine Resources of the Western Central Pacific. Volume I, Seaweeds, corals, bivalves And gastropods. Pp.123-686.FAO, Rome, ISBN 92-5-104051-6.

Raje, S.G. S. Sivakami, G. Mohanraj, P.P. Manojkumar, A.Raju and K.K. Joshi. 2007. An atlas of the elasmobranch fishery resources of India. CMFRI special Publication no.95.

24. Subramaniam, T. V., K.R. Karandikar and N.N. Murthy . 1952. Marine Gastropods of Bombay Part II. J. Bombay University. Vol 21. 26-73.

Subramaniam T. V., K.R. Karandikar and N.N. Murthy . 1949. Marine Pelecypods of Bombay Part I. J. Bombay University. Vol 17. 50-81.

Subramaniam, T. V., K.R. Karandikar and N.N. Murthy . 1951. Marine Gastropods of Bombay Part I. J. Bombay University. Vol 3. 21-34.

Talwar P. K. and Jhingran A.G., 1991. Inland fishes of India and adjacent countries, Delhi Oxford & IBH Publishing Co. Pvt. Ltd. 1158 p. Vol. I & II

Talwar, P.K. and Kacker, R.K., 1984. Commercial sea fishes of India. Published by ZSI, Kolkata. 997 p.

Thomas D., Kocher and Carol A. Stepien (Ed.). 1997. Molecular systematics of Fishes. Academic Press. New York .314p.

Whitmore, D.H., 1990. Electrophoretic and Isoelectric focusing techniques in fisheries management. 350pp.

FRM 510	INLAND FISHERIES RESOURCES MANAGEMENT	2+1
Objectives	To understand the present exploitation and future potential of inland fisheries. To learn the methodologies for assessments of inland fisheries resources	
Theory		

Unit I	Freshwater fisheries resources India-world: Ponds, lakes, bheels, tanks, estuaries, brackish water lagoons, wetlands, biosphere reserves and mangroves and derelict water bodies their problems and management aspects. Assessment of carrying capacity of different inland water bodies; Water budgeting. Community participation in fishery resource management.
Unit II	Bheel fisheries resources of India: Open and closed bheels, productivity conditions, Capture scenario, prospects of culture based systems.
Unit III	Riverine fisheries resources in India: Present trend of dwindling fisheries resources, direct and Indirect effects of human intervention in rivers, habitat modification and improvement (rehabilitation of channels and flood plains), protection and restoration of fish movements (different types of fish passes and enhancement of fish migration), management and repair of riverine vegetation, stock enhancement strategies like introduction of new species, pre- and post- stocking management, potential risk of stocking.
Unit IV	Cold water fisheries of India: Present trends, problems due to habitat destruction, management aspects, prospects of sports fisheries in India.
Unit V	Reservoir Fisheries in India: Classification of reservoirs, present productivity levels, management practices.
Unit VI	Estuarine fisheries in India: classification of estuaries- present productivity level potential; Problem – management practices.
Practical	Freshwater fish identification. Tagging – different types of tags. Visit to nearest freshwater body; catching methods – catch data analysis on major freshwater resources- Bheels- Estuaries - Reservoirs –lakes. Biodiversity indices – Gear selectivity.
Suggested Readings	Blaber JM. 1997. Fish and Fisheries in Tropical Estuaries Chapman & Hall. FAO. Technical Papers on Freshwater Fisheries. Jhingran VG & Pathak V. 1987. Ecology and Management of Bheels in Assam: A case study of Dhir Bheel. In: Workshop on Development of Bheel Fisheries in Assam, held at Assam Agricultural University, Guwahati from 21st to 22nd April. Jhingran VG & Sehgal KL. 1978. Cold Water Fisheries of India. J. Inland. Fish. Soc. India. Sp. Publ. Jhingran VG. 1991. Fish and Fisheries of India. 3rd Ed. Hindustan Publ. Sugunan VV. 1997. Reservoir Fisheries of India. Daya Publ. House.

FRM 511	MARINE FISHERIES RESOURCES MANAGEMENT	2+1
Objective	To know the present level of exploitation of marine resources and to impart knowledge on conservation measures. To learn the recent methodologies of sustainable exploitation of renewable resources.	
Theory		
Unit I	Status of marine fisheries: Major fishing nations of the world, major fishing regions, present trend of marine capture fisheries.	
Unit II	Marine fish resources: Important finfish and shellfish resources in demersal and pelagic systems; conservation strategies.	
Unit III	Fishery management: Mud bank fishery- wadge bank fishery- Commonly used tools for input and output regulations. Principles of management of fisheries resources, objectives of management, issues and challenges of managing multi-gear fisheries.	
Unit IV	Sustainability: Principles, socio-economic, ecological, biological and legal issues- Fisheries co-management - Case studies of fisheries conflicts between sectors, states and nations. Conflict management.	
Unit V	Fisheries and fishing methods in open waters: Inshore fisheries (up to 50 m depth), offshore fisheries (50-200 m depth) -High sea fisheries.	
Unit VI	Conservation aspects: Marine Biodiversity of selected areas including coral reef conservation. Biodiversity principles, categorization of species into endangered; Indeterminate and extinct varieties- managing the highly exploited fishery resources.	
Practical	Marine fishery resources – visit to nearest marine landing centres. Length frequency analysis – catching method. Catch data analysis on marine fishery resources of India. Closed season studies – gear selectivity.	
Suggested Readings	Bal DV& Rao KV. 1990. Marine Fishes of India. 1st Revised Ed. Tata McGraw Hill. Chandra P. 2007. Fishery Conservation, Management and Development . SBS Publ. Dholakia AD. 2004. Fisheries and Aquatic Resources of India. Daya Publ. House. FAO. Technical Papers on Marine Fisheries. Kurian CV & Sebastian VO. 1986. Prawns and Prawn Fisheries of India. Hindustan Publ. Corp. Peter BM& Joseph JC. Jr. 2000. Fishes- An Introduction to Ichthyology. 4th Ed. Prentice Hall. Samuel CT. 1968. Marine Fisheries in India. Narendra Publ. House. Shanbhogue SL. 2000. Marine Fisheries of India.. ICAR. Yadav BN. 1997. Fish and Fisheries. 2 nd Ed. Daya Publ. House.	

FRM 512	ADVANCED FISH ANATOMY AND PHYSIOLOGY	2+1
Objective	To impart an in depth knowledge on anatomy and physiological regulations in fishes for better fisheries resource management	
Theory		
Unit I	Principles of Fish anatomy: Study of internal anatomy of important groups of finfish and shellfish. Body form, swimming mechanisms and buoyancy regulation- bioenergetics, strategies for buoyancy regulation- Fish behaviour and regulatory mechanism- alarm reaction- transduction mechanism. Sense organs and their functions. Hearing mechanism and specialization. Physiology of photoreceptors and pineal organ.	
Unit II	Anatomy and physiology of digestive system: digestive organ and their mechanism, functions, feed ingestion and feeding mechanism - Feeding mechanisms and their control, effect of starvation.	
Unit III	Anatomy and physiology of excretory system: Excretory organs in fish and shellfish and their functions. Mechanism of excretion of nitrogenous waste. Osmoregulation in freshwater fishes, marine fishes, elasmobranchs, crustaceans and molluscs.	
Unit IV	Muscle physiology: striated and smooth muscle, Adaptations of muscles for various activities, Neuronal control of muscle contraction, Electric organs. Stenohaline and Euryhaline animals and their tolerance capacity.	
Unit V	Endocrine and exocrine glands: hormones and their role in appetite, osmoregulation, calcium metabolism, cardiovascular regulation and behaviour, hormone receptors, endocrine disruption. Mechanism of hormone synthesis, release, transport and action. Hormone receptors and their characteristics. Neuroendocrine regulation of gametogenesis, maturation and ovulation processes.	
Unit VI	Adaptations to Stress: basic concept of environmental stress, acclimatization, avoidance and tolerance, stress and hormones.	
Practical	Dissection of different shellfishes and finfishes to understand their internal organs. Influence of temperature and salinity on metabolism. Display of visceral organs; dissection of fish bones and skeleton. Oxygen consumption in relation to body size/stress/anesthesia. Chronic and acute responses to environmental changes (temperature and salinity) on metabolism. Collection and analysis of body fluids, blood sampling; gamete collection. Oxygen consumption in relation to body size/stress/anesthesia. Haematology. Acute and chronic stress markers (estimation of glucose, cortisol, total protein, AST, ALT, LDH). Analysis of digestive enzyme activities. Measuring osmoregulatory parameters. measuring reproductive hormones; Audio visual recording of behaviour in simulated experiment.	

Suggested Reading	<p>Smith, Lynwood S." 1999. Introduction to fish physiology. Narendra Publishing House</p> <p>Nielsen , 1983. Animal Physiology: adaption and environment New York Cambridge University Press Edition: 3rd : "xii, 619p"</p> <p>Val , 2006. Physiology of tropical fishes. California Elsevier Academic Press : "xiv, 634p" ; 23cm ISBN: 0-12-350445-7</p> <p>Diwan, 2007. Physiology of marine white shrimp: Fenneropenaeus indicus. Delhi Narendra Publishing House: "x, 245p." ISBN: 81-85-375-93-3</p> <p>Evans, 2014. Physiology of fishes. Boca Raton CRC Press 2014 Edition: 4th : "xiv, 453p" ISBN: 978-1-4398-8030-2</p> <p>Rocha, 2008. Fish reproduction. Enfield "Science Publishers, Inc. xiii, 629p" ISBN: 978-1-57808-331-2</p> <p>Reinecke, 2006. Fish endocrinology, Vol. 1": Enfield "Science Publishers, Inc. : "xx, 440p" ISBN: 9781578083183</p> <p>Reinecke , 2006. Fish endocrinology, Vol. 2": Enfield "Science Publishers, Inc. : "xx, 441-871pp" ISBN: 978-1-57808-415-9</p> <p>Johnston, 2014. Fish physiology (Series 1-35 volumes) New Delhi Reed Elsevier India Private Limited 2014 : "v, 318p" ISBN: 978-93-5107-130-3</p> <p>Samantaray, 2015. Physiology of finfish and shellfish.: New Delhi New India Publishing Agency 2015 : "xviii, 230p" ISBN: 978-93-83305-68-1</p> <p>Evans DH & Claiborne JB. 2006. The Physiology of Fishes. CRC Press.</p> <p>Hoar WS & Randall DJ. 1988. Fish Physiology. Academic Press.</p> <p>Scharrer E. 1963. Neuroendocrinology. Columbia University Press.</p> <p>Thomas PC, Rath SC & Mohapatra KD. 2003. Breeding and Seed Production of Finfish and Shellfish. Daya Publ. House.</p> <p>Conn EE & Stumpf PK. 1987. Outline of Biochemistry. Wiley.</p> <p>Northcutt RG & Davis RE. 1983. Fish Neurobiology. University of Michigan Press</p> <p>Alan GH. 1995. Water Pollution and Fish Physiology. CRC Press.</p> <p>William O. Reece, Eric W. Rowe, 2017. Functional Anatomy and Physiology of Domestic Animals, 5th Edition. ISBN: 978-1-119-27086-7 , Wiley-Blackwell p. 576.</p> <p>Chavin W. (Ed.). 1973. Responses of Fish to Environmental Changes. Charles C Thomas Publ</p> <p>Jobling M. 1995. Environmental Biology of Fishes. Springer.</p> <p>Pickering AD. 1981. Stress and Fish. Academic Press.</p> <p>22. Rankin JC & Jensen FB. 1996. Fish Ecophysiology. Chapman & Hall.</p>
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FRM 513	FISH HISTOLOGY AND HISTOCHEMISTRY	1+1
Objectives	<p>To know the present level of exploitation of marine resources and to impart knowledge on conservation measures.</p> <p>To learn the recent methodologies of sustainable exploitation of renewable resources.</p>	
Theory		

Unit I	Fundamentals of histology: Epithelial, connective, muscular, nervous and other specialized tissues.- Tools in histology: Principles, design and functioning of microtomes, automated microtomes, ultra microtome, cryostat, problems and troubleshooting.
Unit II	Techniques in histology: Sample preparation, obtaining tissue samples, handling reagents, fixatives (types of fixatives and effect on tissue), processing of fixed samples, dehydration(procedure and significance), embedding, block making, staining(staining methods histochemical and immunohistological methods), dyes and dye binding reactive groups, mordants and mordanting, temporary and permanent preparations, whole mount preparation
Unit III	Fundamentals of histochemical techniques: principle and practice, detection of glycogen, neutral and acid mucopolysaccharides, detection of basic proteins, detection of specific and nonspecific lipids, detection of nonspecific esterases, detection of acid /alkaline phosphatase.
Unit: IV	Systemic Histology: Study of Microscopic structure of the organs of digestive, respiratory, urinary, reproductive, nervous and cardiovascular systems, sense organs, endocrines and lymphoid organs of fish and shellfish
Practical	Histology slide preparation- studying the general architecture of various tissues- staining- vital staining- histochemistry. Enzyme detection: acid phosphatase, alkaline phosphatase, esterases. Nucleic acid staining: methyl green, pyronine, feulgen stain. Study of different types of tissue with help of permanent slides. Effect of fixatives, fixation of tissues. Block preparation and sectioning. Mucopolysaccharide staining, AB pH 1.5, 2.5. Proteins and lipid staining. Microscopic examination and identification of tissues.
Suggested Readings	Text book of Histology Roland lesson DL. WB Saunders Company, Tokyo. Histology: Roland lesson and Thomas Leesan WB Saunderscompany Co., Canada Histochemistry Vol. I II III A G E pearse Churchill Livingstone NY Franck Genten, Eddy Terwinghe, André Danguy 2009Atlas of Fish Histology, 1 st EditionReference – 224 Pages – 440 Color Illustrations, ISBN 9781578085446 Sonia Mumford; Jerry Heidel; Charlie Smith; John Morrison; Beth MacConnell; Vicki Blazer. Fish Histology and Histopathology Contributing Jonathan A. C. Roques, OmaimahMaghrabi, 2019. Fish Histology.p.326. 7. Doaa M. Mokhtar 2018. Fish Histology: From Cells to Organs. 1 st EditionApple Academic Press p. 264.

FRM 514	FIELD TECHNIQUES IN FISHERIES RESOURCE MANAGEMENT	0+2
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Objective	To learn field skills in fishery biology and resources management
Practical	Planning a fish survey- survey protocol. Fishery dependant sampling- Netting & trapping: Seine nets; Trawl nets; Hand nets, throw nets & push nets; Gill nets & trammel nets (Set nets); Traps- hook & line, Assessing CPUE. Fishery independent sampling Snorkelling- SCUBA survey – line transect- manta survey- Tagging, Underwater Visual Census; Hydro – Acoustics-Electrofishing. Egg and larval collection- abundance estimation.
Suggested Readings	<p>Anderson. , R.O. 1976. Management of small warm water Impoundments. Fisheries (Bethesda, Maryland) 1(6):5-7, 26-28.</p> <p>Anderson, R.O. 1980. Proportional stock density (PSD) and relative weight (Wr): interpretive Indices for fish populations and communities. Pages 27-33 in S. Gloss and B. Shupp, editors. Practical Fisheries management: more with less in the 1980's. Workshop proceedings, New York Chapter, American Fisheries Society, Ithaca, New York, USA.</p> <p>Gabelhouse, D.W., Jr. 1984. A length-categorization system to assess fish stocks. North American Journal of Fisheries Management 4:273-285.</p> <p>Wege, G.J., and R.O. Anderson. 1978. Relative Weight (Wr): a new Index of condition for largemouth bass. Pages 79-91 in</p> <p>G.D. Novinger and J.G. Dillard, editors. New approaches to the management of small impoundments. Special Publication 5, North Central Division, American Fisheries Society, Bethesda, Maryland, USA</p> <p>English, S., Wilkinson, C. & Baker, V. (1994) Survey manual for tropical marine resources. ASEAN Australian Marine Science Project: Living Coastal Resources, Townsville. 368pp.</p> <p>Dartnall, A.J. & Jones, M. (1986) A manual of survey methods for living resources in coastal areas. Australian Institute of Marine Science, Townsville, Australia. 167pp.</p> <p>Veron, J.E.N. (1986) Corals of Australia and the Indo- Pacific, Townsville. Australian Institute of Marine Science. 644pp.</p> <p>Richmond, M.D. (1997) A guide to the seashores of eastern Africa and the Western Indian Ocean islands. Sida-SAREC, Sweden. 448pp</p>

Course Contents
Ph.D. (Fisheries Resource Management)

FRM 601	FISHERIES RESOURCE CONSERVATION AND RESTORATION BIOLOGY	2+1
Objective	To understand the protection needs of fisheries resources and aquatic system and restore them to sustain the fisheries resources	
Theory		
Unit I	Functions and importance of Aquatic habitats: Mangrove, Corals, Seagrass beds, and dunes, Turtle nesting grounds, horseshoe crab habitat; Role and functions of aquatic habitat; Human activities and pollution sources; Effects of Conservation Practices on Aquatic Habitats and Fauna	
Unit II	Aquatic habitat conservation: Freshwater habitat and Marine water habitat; Erosion and sediment control-transplantation-stocking-population stabilisation	
Unit III	Restoration and Management; Restoration of freshwater and marine water; Storm water management; restoration challenges of aquatic habitats- Spawning/feeding ground protection, fish refugee- ex-situ conservation	
Unit IV	Marine parks: formation guidelines- Ecosystem stability- Population viability-effect-coral restoration- seagrass meadow formation-artificial reef-heritage sites-protection of spawning aggregates-ranching- relocation-critical stock/ critical viability stock-bio-augmentation.	
Unit V	Land development guidelines for protection of aquatic habitats; Beach creation and beach maintenance –Aquatic habitat protection and restoration programs, projects and policies; Governance and regulation	
Unit VI	Ecosystem Valuations: Carbon sink- carbon Budgeting –Economic and financial aspects; Economic value of aquatic habitat.	
Practical	Visit to natural aquatic habitats like ponds, lakes, rivers, streams, springs, estuaries, bays, and various types of wetlands. Visit to Marine national parks- Eco-sensitive zones. Sampling methods; Isolation, identification and enumeration of aquatic organisms from diverse aquatic habitats; Suggest management plan for aquatic habitat protection- permit application form. Valuation of ecosystems – awareness on fisheries resource conservation. Visit to reservoir and assess the threats and developing plan for stock rebuilding. Seagrass, Mangrove restoration. Reservoir stock/ ranching	

Suggested Readings	<p>Dawson CL & Hellenthal RA. 1986. A Computerized System for the Evaluation of Aquatic Habitats Based on Environmental Requirements and Pollution Tolerance Associations of Resident Organisms. EPA/600/S3-86/019. Environmental Research Laboratory, U.S. Environmental Protection Agency, Corvallis, Oregon.</p> <p>Ramachandra, 2005. Aquatic ecosystems: conservation, restoration and management. Description: New Delhi: Capital Publishing Company : “xiii, 348p” ; 25cm ISBN: 81-85589-38-0</p> <p>Ramasubramanian, 2004. Mangroves forest restoration in Andhra Pradesh, India” Description: Chennai M. S. Swaminathan Research Foundation : 26p Books</p> <p>Rogers, Caroline S.1994 . Coral reef monitoring manual for the Caribbean and western atlantic</p> <p>McClanahan, 2000. Coral reefs of the Indian ocean: their ecology and conservation. Oxford Oxford University Press: “ xxiii,525p” ISBN: 0-19-512596-7</p> <p>Larkum. 2007 “Seagrass: biology, ecology and conservation.Dordrecht Springer: xvi, 691p” ISBN: 978-1-4020-2942</p> <p>Arthur, 2008. Integrated monitoring protocol for seagrass ecosystems: a field manual Description: New Delhi The United Nations: 43p</p> <p>Ben-Yami, M.1989. How to make and set FADs: fish aggregating devices Published by: “Food and Agricultural Organization of the United Nations, Rome.</p> <p>Lim, 1998. Carrying capacity assessment of PulauPayar Marine Park, Malaysia. Chennai BOBP 1998 : 129 Books</p> <p>Leber, 2004. Stock enhancement and sea ranching: developments, pitfalls and opportunities. Published by: “Blackwell Publishing Inc.,” (Malden) 2nd.Description: “xii, 562p.” 1-4051-1119-4.</p> <p>Thorpe JE, Gall GAE, Lannan JE & Nash CE. (Eds.). 1995. Conservation of Fish and Shellfish Resources, Managing Diversity.</p> <p>Nath S. (Ed.). 2008. Recent Advances in Fish Ecology Limnology and Eco Conservation. Vol. VII. Narendra Publ. House</p> <p>Young TP. 2000. Restoration Ecology and Conservation Biology. Biological Conservation.</p>
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FRM 602	ASSESSMENT OF AQUATIC BIODIVERSITY AND ECOSYSTEM	2+1
Objective	To enrich the knowledge on aquatic biodiversity, assessment of healthiness using indices, threats and conservation needs	
Theory		

Unit I	Introduction to Aquatic Biodiversity assessment: Measurement, Methods for sampling and analysis, scales and indices of biodiversity assessment – Biodiversity monitoring- Biotic integrity index-fish- Benthos-Plankton.
Unit II	Biodiversity assessment in ecosystems: (Inland and Marine Resources) Rivers, lakes, estuaries intertidal (mangrove and coral reefs) and gulf and island ecosystem.
Unit III	Threats to biodiversity: Overexploitation, land reclamation, exotic species – pollution, habitation, climate change, conversion of agricultural land and aquacultural farms (case studies pertaining to sensitive marine/estuarine/freshwater hot spots).
Unit IV	Impacts of anthropogenic intervention on aquatic biodiversity: Damming of rivers, linking of rivers. Construction of sea walls, micro hydel power stations, oil rigs. Biodiversity loss, extinction risk and endangered species management.
Unit V	Conservation and Restoration: Declaration of mangrove sanctuaries and mangrove afforestation, marine protected areas, Riverine ecosystem and diversity management Plan, introduction of exotic species and their implications. Bio-monitoring, Genetic diversity and conservation.
Unit VI	Ecosystem Conservation Acts: Legal and institutional acts, regimes of biodiversity: International and national conventions, Biodiversity Acts- Biodiversity Boards/Authority, Benefit sharing mechanism- IUCN criteria – Red List, Wildlife protection act, International treaties, ETP species.
Practical	Preparation of records and inventories of biodiversity of any three critically important ecosystems based on secondary data and field visits. Comparison of biodiversity indices; assessment of biotic integrity index. Compilation of all important International and National laws and conventions related to biodiversity. Collection and identification of flora and fauna from biodiversity hotspot. Identification of scheduled aquatic fauna. Data sheet preparation on IUCN criteria. Assess threats to aquatic biodiversity. Development of conservation plans. Analysis of earlier biodiversity study reports.
Suggested Readings	Brian G. 1992. Global Biodiversity – Status of the Earth’s Living Resources. Chapman & Hall. Denton TE. 1973. Fish Chromosome Methodology. Charles Thomas Publ. Elliott A. Norse (Ed.) 1993. Global marine Biological Diversity. Inland press, Washington, D.C. 383p.

Gunderson DR. 1993. Surveys of Fisheries Resources. John Wiley & Sons. New York. 248 p.

Khanna DR, Chopra AK & Prasad G. 2005. Aquatic Biodiversity in India. Daya Publ. House.

Kumar U & Asija M. J. 2000. Biodiversity Principles and Conservation. Agrobios.

Lakra WS, Abidi R, Singh AK, Sood N, Rathore G & Swaminathan TR. 2000. Fish Introductions and Quarantine: Indian Perspective. National Bureau of Fish Genetic Resources (NBFGR), Lucknow.

Lambhead PJD, Paterson GLJ & Gage JD. 1997. Biodiversity Professional. Version 2. National History Museum and the Scottish Association of Marine Science.

Magurran AE. 1988. Ecological Diversity and its Measurement. Taylor & Francis.

Mahanta PC & Tyagi LK. 2003. Participatory Approach for Fish Biodiversity Conservation in North East India. National Bureau of Fish Genetic Resources (NBFGR), Lucknow.

Ponniah AG & Gopalakrishnan A. (Eds.). 2000. Endemic Fish Diversity of Western Ghats. National Bureau of Fish Genetic Resources (NBFGR), Lucknow.

Zoological Survey of India. 2007. National Symposium on Conservation and Valuation of Marine Biodiversity.

WCMC. 1992. Global Biodiversity: Status of the Earth's Living Resources. Chapman & Hall.

Mahanta PC & Tyagi LK. 2003. Participatory Approach for Fish Biodiversity Conservation in North East India. National Bureau of Fish Genetic Resources (NBFGR), Lucknow.

Menon AGK. 2004. Threatened Fishes of India and their Conservation. Fisheries Survey of India.

Michael RR. 1997. Fisheries Conservation and Management. Prentice Hall.

Pascoe S. 2005. Bycatch Management and the Economics of Discarding. Daya Publ. House.

Thorpe JE, Talbot C & Miles MS. (Ed.) 1995. Conservation of Fish and Shell Fish Resource; Managing Diversity. Academic Press.

FRM 603	FUNCTIONAL PHYSIOLOGY OF FISHES	2+1
Objective	To understand advanced concepts in physiology of finfish and shellfishes	
Theory		
Unit I	Growth and metabolism: BMR- SDA- Bioenergetics-energy requirement of fish-energy budgeting-digestion-liver function- starvation effect.	

Unit II	Sense organs and their functions: Hearing mechanism and specialization. Vision and mechanosensation – photoreceptors; Olfaction. Vision
Unit III	Neurophysiology: nerve gap junction-potential-nerve pulse-passage-circadian rhythm.
Unit IV	Endocrinology physiology: migration physiology, endocrine glands- hormone-endocrine disruptor- Osmoregulation: Excretion- Blood parameters and hormones- Regulation of electrolytes and ions.
Unit V	Reproductive physiology: Reproductive behaviour – hormones- embryonic development – Pheromones and other signals- Ecomorphology; strategies for buoyancy regulation.
Unit VI	Stress physiology: stress resistance, stress tolerance- General Adaptive Syndrome- immune system – responses to temperature, hypoxia and anoxia
Practical	Fish anaesthetisation. Analysis of blood composition –blood volume measurement. Histological analysis of gills. Energy requirement studies. Estimation of gross energy and digestible energy of feed. Measuring osmoregulatory parameters. Measuring of cortisol –water regulation. Measuring reproductive hormones. Electro-olfactograms. Chronic and acute responses to environmental changes. Stress study- symptoms. Observe embryonic development.
Suggested reading	Smith, Lynwood S.” 1999. Introduction to fish physiology. Narendra Publishing House Nielsen , 1983. Animal Physiology: adaption and environment New York Cambridge University Press Edition: 3 rd : “xii, 619p” Val , 2006. Physiology of tropical fishes. California Elsevier Academic Press : “xiv, 634p” ; 23cm ISBN: 0-12-350445-7 Diwan, 2007. Physiology of marine white shrimp: <i>Fenneropenaeusindicus</i> . Delhi Narendra Publishing House: “x,245p.” ISBN: 81-85-375-93-3 Evans, 2014. Physiology of fishes. Boca Raton CRC Press 2014 Edition: 4 th : “xiv, 453p” ISBN: 978-1-4398-8030-2 Rocha, 2008. Fish reproduction. Enfield “Science Publishers,Inc. Xiii, 629p” ISBN: 978-1-57808-331-2 Reinecke, 2006. Fish endocrinology, Vol. 1”: Enfield “Science Publishers, Inc. : “xx, 440p” ISBN: 9781578083183 Reinecke , 2006. Fish endocrinology, Vol. 2”: Enfield “Science Publishers, Inc. : “xx, 441-871pp” ISBN: 978-1-57808-415-9 9. Johnston, 2014. Fish physiology (Series 1-35 volumes) New Delhi Reed Elsevier India Private Limited 2014 : “v, 318p” ISBN: 978-93- 5107-130-3 Samantaray, 2015. Physiology of finfish and shellfish.: New Delhi New India Publishing Agency 2015 : “xviii, 230p” ISBN: 978-93- 83305-68-1 Evans DH & Claiborne JB. 2006. The Physiology of Fishes. CRC Press.

	<p>Hoar WS & Randall DJ.1988. Fish Physiology. Academic Press.</p> <p>Scharrer E. 1963. Neuroendocrinology. Columbia University Press.</p> <p>Thomas PC, Rath SC & Mohapatra KD. 2003. Breeding and Seed Production of Finfish and Shellfish. Daya Publ. House.</p> <p>Conn EE & Stumpf PK. 1987. Outline of Biochemistry. Wiley.</p> <p>Northcutt RG & Davis RE. 1983. Fish Neurobiology. University of Michigan Press</p> <p>Alan GH. 1995. Water Pollution and Fish Physiology. CRC Press.</p> <p>18. William O. Reece, Eric W. Rowe, 2017. Functional Anatomy and Physiology of Domestic Animals, 5th Edition. ISBN: 978-1-119- 27086-7 , Wiley-Blackwell p. 576.</p>
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FRM 604	GIS USE IN FISHERIES RESOURCES	2+1
Objective	To apply the knowledge in GIS for assessment and management of fisheries sector	
Theory		
Unit I	GIS in Fisheries: Applications of geographical information systems (GIS) based on spatial decisions in fisheries resources.	
Unit II	GIS applications in MPA: Application of GIS to evaluate efficiency of marine protected areas in India.	
Unit III	GIS in shrimp aquaculture: Applications of GIS for sustainable management of shrimp culture in India.	
Unit IV	Fish modelling: Modelling of essential fish habitats based on remote sensing, spatial analysis and GIS	
Unit V	Geographical information systems: Their past, present and future use in global marine fisheries.	
Unit VI	GIS applications in Mangroves: Application of GIS in the management of mangrove forests and Marine Protected Area.	
Practical	Applications of GIS software in fisheries resource management. Mapping of fisheries resources using GIS. Exercises in Arc GIS/ Open sources software.	
Suggested Readings	<p>FAO. 2003. <i>Geographic Information Systems in fisheries management and planning. Technical manual</i>, by G. De Graaf, F.J.B. Marttin, J. Aguilar-Manjarrez & J. Jenness. FAO Fisheries Technical Paper No. 449. Rome. 162p.</p> <p>COPEMED. 2001b. <i>GIS in fisheries management, Training manual, Higher national diploma in fisheries science for the Mediterranean countries</i>. Rome, Italy, Department of fisheries and aquaculture (Malta), University of Plymouth (UK) and COPEMED (FAO). 135 pp.</p>	

FAO. 1996. *Geographical information systems. Applications to marine fisheries*, by G.J. Meaden & Do Chi. FAO Fisheries Technical Paper No. 356. Rome. 335 pp. (available at: <http://www.fao.org/DOCREP/003/W0615E/W0615E00.HTM>).

FAO. 1997a. *A strategic assessment of the potential for freshwater farming in Latin America*, by J.M. Kapetsky & S.S. Nath. FAO COPESCAL Technical Paper No. 10. Rome. 128 pp. (available at: <http://www.fao.org/DOCREP/005/W5268E/W5268E00.HTM>).

Valavanis, V.D. 2002. *Geographic Information Systems in Oceanography and Fisheries*. London, Taylor & Francis. 209 pp.

Morain, Stanley A. 1999. GIS solutions in natural resource management. “

Sahu, 2008. Textbook of remote sensing and geographical information system. New Delhi Atlantic Publishers & Distributors 2008 : x;499

Schuurman, 2003. GIS ; a short introduction. : Malden “Blackwell Publishing Inc.,” 2003 : xiii;169 ISBN: 0-631-23532-9

Carocci, 2009. Geographic information systems to support the ecosystem approach to fisheries: status, opportunities and challenges” FAO Fisheries and Aquaculture Technical Paper; No. 532. Description: Rome Food and Agriculture Organization of the UN: “xv, 101p” ISBN: 978-92-5-106433-7

Pandey, 2014. Geographic information system. New Delhi The Energy and Resources Institute 2014 : “xvii, 151p” ISBN: 978-81- 7993-537-8

Boca Raton, 2014. GIS: fundamentals Wise Description: CRC Press Edition: 2nd : “xv, 322p” ISBN: 978-1-4398-8695-3

Zhu, Xuan, 2016. GIS for environmental applications: a practical approach Description: New York Routledge: xvi,471p ISBN: 978-0-415- 82906-

Meaden, Geoffery, J. 1991. Geographical information systems and remote sensing in inland fisheries and aquaculture Description: “Food and Agricultural Organization of the United Nations.

Faiz, Sami, 2013. Geographical information systems and spatial optimization. Boca Raton CRC Press : xxii,154p ISBN: 978-1-4665-7747-3

Jeff Thurston Thomas K Poiker & J Patrick Moore. 2000. Integrated Geospatial Technology – A Guide to GPS, GIS and Data Logging. John Wiley & Sons.

Kraak MJ & Ferjan O. 2003. Cartography, Visualization of Spatial Data. Prentice Hall.

Meaden GJ & Kaptesky JM. 1991. Geographical Information Systems and Remote Sensing in Inland Fisheries and Aquaculture. FAO Fisheries Tech. Paper No. 318, Rome.

Patel AN & Singh S. 1992. Remote Sensing – Principles and Applications. Scientific Publ.

Valavanis VD. 2002. GIS System in Oceanography and Fisheries. Taylor & Francis.

FRM 605	FISHERIES LEGISLATIONS, GOVERNANCE AND TREATIES	1+1
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Objective	To familiarise various legislation, agreement under international law which govern responsible utilisation of fisheries resources	
Theory		
Unit I	Overview of legislation: critical review of fisheries regulatory and developmental setup in centre and states (spheres of responsibility and division of power); need for fisheries management; regulatory, legal and enforcement regimes. Developmental planning for fisheries; plan allocation, programs and performance of fisheries sector; regional disparities and balanced development; political economy of fisheries development political ecology	
Unit II	National policies and regulations: objectives, salient features and amendments: Indian Fisheries Act, Biodiversity Act, The Environmental (Protection) Act; Policy and regulatory environment in Marine Fisheries and mariculture Sector (National Policy on Marine Fisheries, MFRA, Deep sea fishing policy, Guidelines for deep sea vessels, Policy on Mariculture, seed certification), Inland Fisheries and Aquaculture Sector (National Policy on Inland Fisheries and Aquaculture), wet lands, Heritage sites, hot spots; Brackishwater Aquaculture Sector (CAA), Processing Sector (MPEDA Act; HACCP/ ISO Standards / Food safety/ Quality Safety Management Systems). Fish Marketing and Trade policies, institutionalization of stakeholder participation and Developing policy framework for fisheries	
Unit III	International policy and regulatory scenario in fisheries sector: FAO's CCCRF; IUU; MCS; UN's Law of the Sea and other conventions; treaties; SAARC, NACA, CBD, CITES, MARPOL, IWC, EU's Common Fisheries Policy, RAMSAR- SDG- RFMOs ; Fisheries policy and regulation of selected countries in Asian American and Australian regions. Eco-labeling and Certification.	
Unit IV	Governance: Need for fisheries governance & institutional framework. Formal and traditional. Fisheries Law. Rights based fisheries. Improve fisheries governance. Multi-stakeholder processes in governance, Case studies in self-governance in the fisheries sector	
Practical	Review of the existing fisheries policies: suggest and draft ideal inland and marine fishery legislations for India. Fisheries regulatory, legal and enforcement regimes- responsibilities of the centre and states of India.	
	Preparation of management plans for specific fisheries. Visit to appropriate Government organizations/research, institutions/NGOs and preparation of working report. Impact survey on regulations- group discussion on fisheries regulations. Comparison of policies and acts with neighbouring countries. Comparison of Fisheries Regulation Acts of different states.	

<p>Suggested Readings</p>	<p>Kumar. U. Biodiversity Principles and Conservation, Narendra Publishing House Publishers & Distributors.</p> <p>Ponniah, A.G. and A. Gopalakrishnan (Eds.)2000. Endemic fish diversity of western Ghats NBFGR, Lucknow 347 p.</p> <p>“Christy, Lawrence C.1980. Fisheries legislation in Somalia. “Food and Agricultural Organization of the United Nations,” 1980</p> <p>Pandey, 2014. Fisheries governance and legislation in India. Delhi Narendra Publishing House 2014 : “xviii, 182p” ISBN: 978- 93-82471-85-1</p> <p>Burke, William T. 1992. Fisheries regulations under extended jurisdiction and international law: “Food and Agricultural Organization of the United Nations.</p> <p>Dixit , 2013. Regulating oceanic fishing: international laws and treaties. Delhi Swastik Publications: “viii, 264p” ISBN: 978-93- 81991-04-6</p> <p>Raval, 2013. Combating marine pollution: international laws and regulations. New Delhi Cyber Tech Publications 2013 : “viii, 264p” ; 21x13cm ISBN: 978-93-5053-150-1</p> <p>Gray, 2005. Participation in Fisheries Governance. Dordrecht Springer: xxv;363 ISBN: 978-1-4020-3777-1</p> <p>Anon. 1998. Maritime Law of India in the International Context. Bhadarkar Publ.</p> <p>Brahtz JFP. 1972. Coastal Zone Management. U.N. International Economic and Social Affairs, New York.</p> <p>Churchill RR & Lowe AV. 1988. Law of the Sea. Manchester University Press.</p> <p>Henkin L, Pugh RC & Smit H. 1993. International Law: Cases and Materials. West Publ. Co.</p> <p>Sinha RK. (Ed.). 1996. Marine Resources and Applicable Laws (World Environmental Series – 009). Commonwealth Publ.</p> <p>Vergheese CP. 1989. Fishing Regulation in India’s Territorial Waters. World Fishing.</p>
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FRM 606	SOFTWARE APPLICATIONS IN FISH STOCK ASSESSMENT	1+1
Objective	To familiarise various software available for stock assessment and use for taking decision to optimally exploit the stock	
Theory		
Unit I	Introduction to sampling and data collection: Collection of fishery data-field procedure-abundance estimation-transect Study- Sampling-survey-fish landing centre-exploratory survey-fishery independent survey –non-extractive abundance sampling-catch effort assessment.	
Unit II	Models: single species – Biomass dynamics, Cohort analysis, YPR, Depletion model; multispecies – Descriptive multispecies, dynamic multispecies, aggregate system and dynamic system models.	
Unit III	Softwares: Software for fish stock assessment-open source. Computer based softwares, FiSAT/CEDA/LEDA/LFDA	
Unit IV	R program: basics- Application of R program in fisheries.	
Practical	Collection of fishery data at landing centres from different gears separately. Details of craft and gear of landing centres and recording of data in the entry forms. Collection of length frequency data for various groups of finfish and shellfish. Estimation of age and growth based on length frequency data. Growth, mortality, population and stock parameters employing computer based softwares, FiSAT/CEDA/LEDA/LFDA, YIELD and PAR Fish Length structured VPA, Thompson and Bell yield stock prediction for single and multi-fleet version. RAPFISH. Types of simulation model: yield-per-recruit and dynamic logistic model. Multispecies model-Multispecies Virtual population dynamics. Beverton and Holt yield-per-recruit model; biomass-per-recruit. Relative yield-per-recruit model and yield isopleth. ECOPATH With ECOSIM. Introduction to R program in fisheries. R- programme in stock assessment.	
Suggested Readings	<p>FAO, 2005. FISAT II - FAO-ICLARM Stock Assessment Tools II: User's Guide (Computerized Information Series: Fisheries) Paperback – Import, 15 Dec 2005</p> <p>Christensen, V, C.J. Walters and D. Pauly. 2005. Ecopath with Ecosim: a User's Guide. Fisheries Centre, University of British Columbia, Vancouver. November 2005 edition, 154 p. (available online at www.ecopath.org)</p> <p>Paul Medley. 2003. Participatory Fisheries Stock Assessment Software.p.71.</p> <p>Sparre, P. 1987. Computer Programs for Fish Stock Assessment: Length-based Fish Stock.p.218.</p> <p>Gayanilo, F.C., Jr., Soriano, M., Pauly, D. (1988)A draft guide to the complete ELEFAN. ICLARM Softw. (2): 65p.</p> <p>Keller G. 2001. Applied Statistics with Microsoft Excel. Duxbury.</p>	

FRM 607	Coral reef management	1+1
Objective	To enhance the knowledge on coral reefs, their importance, conservation and restoration management	
Theory		
Unit I	Introduction: Type of coral reefs and their distribution. Origin of coral reefs – coral reefs of the world. Ecology of coral reefs, factors influencing growth, productivity of coral reefs, plants and animals associates of living reef corals and fringing reefs.	
Unit II	Reef types: Types of corals - Soft coral – Hard corals- Biology of corals (Nutrition, production, larval dispersal and settlement) - Coral resource- -field assessment-	
Unit III	Bioactive substances: Bioactive substances of soft and hard corals- extraction- analysis-identification- Classification of bioactive compounds	
Unit IV	Coral reef management: Economic importance of coral reefs- ecological role-threats- sedimentation in coral reef environment- restoration	
Practical	Collection and identification of soft and hard corals, Survey of corals and mapping, identification of associated organisms, preparation of checklist and associated organisms of Indian coast- Predatory animals of corals, Extraction of bioactive substances from soft and hard corals. Observations of destructive methods of corals and coral reef fishes. Coral restoration-valuation.	
Suggested reading	<p>Bakus, G.J. 1994. Coral reef ecosystem. Oxford and IBH publish co. pvt. Ltd. P. 232.</p> <p>Biswas, K.P.2008. Corals of tropical oceans, Daya publishing House, Delhi. 228 p.</p> <p>Frederic M. Bayer. Manfred Gracshoft, Jakob Verseveldt.1983. Illustrated trilingual glossary of morphological and anatomical terms applied to octocorallia, E.J.,Brill, Dr.W. Backhuys Leiden75 p.</p> <p>Frank Talbot and Clive Wilkinson 2001. Coral reefs, management and seagrasses. A source book for managers.Australian Institute of Marine suck Australia, 193p.</p> <p>Caroline S. Rogers et al. 1999. Coral reef monitoring manual for the Caribbean and western Atlantic. National Park service, Virgin Islands National Park.</p> <p>Eugene Rosenberg and Yoss. Loya (Eds.) 2004. Coral Health and disease. Springer, Bartin -488p.</p> <p>James, P.S.B.R. 1986 Recent advances in marine biology. (Dr. Johnes 70th Birthday commemoration volume. Today and tomorrow printers and publishers. P. 591.</p> <p>McClanahan, 2000. Coral reefs of the Indian ocean: their ecology and conservation. Oxford Oxford University Press: "xxiii, 525p" ISBN: 0-19-512596-7</p> <p>Peter Sale, Ed.2006. CORAL REEF FISHES: Dynamics and Diversity in a Complex Ecosystem, Pb Academic Press</p> <p>Pillai, C.G.S. Coral reefs of India</p>	

LIST OF STUDENTS PASSED OUT FROM THE DEPARTMENT

DEPARTMENT OF FISHERIES BIOLOGY**2008**

01.	Systematic and Biology of Estuarine Crab <i>Scylla spp.</i> Of Ratnagiri Coast, Maharashtra	Funde Anil B.	Dr.S.D. Naik Dr. (Mrs.)S.A. Mohite
02	Biology of <i>Sardinella longiceps</i> along Ratnagiri Coast off Maharashtra.	DeshmukhAbhay V.	Dr. S. R. Kovale Dr. Sawant M.S.

2010

01.	Biology of <i>Nemipterus japonicus</i> along the Ratnagiri Coast off Maharashtra	Suresh Kumar P.S.	Dr.S.AMohite e Dr. S.D.Naik
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2011

01	Morphometrics, Gonad Development and Food and Feeding of the White Fish <i>Lactarius lactarius</i> . (Bloch & Schneider, 1801)	AkhadeRoshan R.	Dr. M.S Sawant. Dr. P. D. Redekar
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2012

01.	Biology of <i>Megalaspis cordyla</i> (Linnaeus, 1758) off Ratnagiri Coast, Maharashtra.	JadhavTrupti D.	Dr.S.AMohite
02.	Reproductive Biology of Estuarine Crab, <i>Scylla tranquebarica</i> (Fabricius, 1798) along Ratnagiri Coast, Maharashtra.	SonawaneShivam S.	Dr. S.D.Naik Dr. M.S Sawant.
03	Biological Studies of Indian Mackerel, <i>Rastrelliger kanagurta</i> (Cuvier, 1817) off Ratnagiri Coast, Maharashtra.	Bhendarkar M.P.	Dr. S.D.Naik Dr. (Mrs.)S.A
04	Morphology and Biology of <i>Meretrix meretrix</i> (Linnaeus, 1758) along Ratnagiri Coast, Maharashtra.	Sawant Prajwala P.	Dr. (Mrs.)S.A Mohite

2013

01	Biology of <i>Lepturacanthus savala</i> (Cuvier, 1829) Off Ratnagiri Coast, Maharashtra	Miss. Pakhmode Pallavi K.	Dr. (Mrs.)S.A Mohite
02	Biology of Pony Fish, <i>Leiognathus splendens</i> (Cuvier,1829) Ratnagiri Coast, Maharashtra	Acharya Kanishka V.	Dr.S.D. Naik Dr.G.N. Kulkarni Dr. R.
03	Studies on the Biology of Squid <i>Loligo duvauceli</i> (D'Orbigny,1835) along the Ratnagiri Coast of Maharashtra	Pawar Nitin S.	Shri. B. P. Bhosale Dr. S. D. Naik Dr.M.S. Sawant Dr.V.H. Nirmale Shri. N. D.
04	Morphometric and Genetic Analysis of Pink Perch <i>Nemipterus japonicus</i> Along the West Coast of India	Hakim Mudasir Maqsood	Dr.M.S. Sawant Dr. S. D. Naik Dr. R. A. Pawar Dr. A. S.

FISHERIES RESOURCE MANAGEMENT			
2014			
01	Study of Sexual dimorphism in mantis shrimp	Benjamin Kondowe	Dr.R.A.Pawar Dr.M.S. Sawant
02	Bionomics of Freshwater Crab Resources of Ratnagiri with reference to <i>Barytelphusa cunicularis</i> (Wesrwood,1836)	Beg Nayum A.	Dr.S.D.Naik Dr.S.A.Mohite Dr.G.N.
03	Studies on the Biology of Pony Fish <i>Leiognathus bindus</i> (Valenciennes,1835) along the Ratnagiri Coast of Maharashtra	Biswajit Borah	Dr. V. H. Nirmale Dr. R. A. Pawar Shri. B. P. Bhosale Sr. S. Y.
04	Studies on the Biology of Indian Sand Whiting <i>Sillago sinham</i> (Forsskal,1175) along the Ratnagiri Coast of Maharashtra	Sawant Prutha P.	Shri. B. P. Bhosale Dr. S. D. Naik Dr.V.H. Nirmale Dr. S. Y.
2015			
01	Indigenous Knowledge in Management of Stake net Fishery (Wan) along the Ratnagiri Coast of Maharashtra	Uskelwar Laxman S.	ShriB.P.Bhosale Dr.V.H.Nirmale Dr.S.Y.Metar Shri.N.D.Chogal
02	Studies on the Biology of Tiny Shrimp <i>Parapenaeopsis stylifera</i> (Edwards,1837) of Ratnagiri Coast of Maharashtra	Miss. Rawangave Rekha S.	Dr.S.D.Naik Dr.S.T.Indulkar Dr.V.H.Nirmale
03	Biological Studies of Blood Clam <i>Tegillarca (Anadara) rhombea</i> (Born,1778) along Ratnagiri Coast, Maharashtra	Miss. Meshram Asawari M.	Dr.(Mrs)S.A.Mohite Dr.S.D.Naik Dr.D.I.Pathan
04	Studies on the Biology of Malabar Tongue Sole <i>Cynoglossusma crostomus</i> (Norman,1928) Along the Ratnagiri Coast of Maharashtra	Miss. Bhalekar Pooja V.	Dr.V.H.Nirmale ShriB.P.Bhosale Dr.R.A.Pawar
05	Study of Sexual Size Dimorphism in Mantis Shrimp	Kondowe Benjamin N.	Dr. R. A. Pawar Dr.M. S Sawant Dr. A. S. Pawase
2016			
01	Biological studies on moustached Thryssa, <i>Thryssa mystax</i> (Schneider, 1801) along the Ratnagiri coast of Maharashtra	Kende D. R.	Dr. V. H. Nirmale Dr. R. A. Pawar Shri. N. D. Chogale Dr. S. Y.
02	Morphometrics, Food and feeding and reproductive biology of white sardine, <i>Escualosa thoracata</i> (Valenciennes, 1847) of Ratnagiri Coast	Gurjar U. R.	Dr. M. S. Sawant Dr. R. A. Pawar Dr. V. H. Nirmale Dr. A.S.
03	Studies on Capture Fisheries of Krishna River in Sangali District of Maharashtra	Kokate Amit A.	Bhosale, B. P. Pawar R. A. Metar S. Y. Chogale
04	Study of Spatio-Temporal Variations in the Sponge	Shishir Kumar	Mohite S. A.

	of Ratnagiri Coast, Maharashtra, India		Pawar R. A. Nirmale V. H. Mohite,
2017			
01	Truss morphometric analysis of Great Clam <i>Meretrix Meretrix</i> from Ratnagiri, Maharashtra, India	Miss Darokar Sheetal R.	Dr. Mrs. S. A. Mohite Dr. S. D. Naik Dr. R. A.
02	Biological Studies on dussumier's Thryssa, <i>Thryssa dussumieri</i> (Valenciennes, 1848) along the Ratnagiri coast of Maharashtra	Pawase Sudarshan V.	Dr. V.H.Nirmale Dr. R. A. Pawar ShriB.P.Bhosa
03	Identification of Finfish Seed and its seasonal variation along the Kasarveli Estuary of Ratnagiri Coast of Maharashtra	Balkate Jayesh J.	Naik, S. D. Mohite, S. A. Sawant, M. S. Dhangaye, H.
2019			
01	Biological studies on the Shrimp Scad, <i>Alepes djedaba</i> (Forsskal, 1775) along the Ratnagiri coast of Maharashtra	Bandkar D. S.	Dr. V. H. Nirmale Dr. R. A. Pawar Shri. B. P. Bhosale
02	Biological studies on the Jinga Shrimp <i>Metapenaeus affinis</i> (H. Milne Edwards, 1837) along Ratnagiri coast of Maharashtra	Dongre S. J.	Dr. S. Y. Metar Dr. V. H. Nirmale Dr. S. D. Naik
03	Taxonomic evaluation of species of the family Leiognathidae along the coast of Maharashtra	Godavarikar A. M.	Dr. S. S. Gangan Dr. S. D. Naik Dr. R. A. Pawar Dr.
2020			
01	Gut content correlation of selected marine pelagic fishes with ambient planktonic composition	Golwankar A.P.	Dr. S.A.Mohite
2021			
01	Stock discrimination of vermiculated spinefoot, <i>Siganus vermiculatus</i> , using morphometric techniques from South Konkan coast of Maharashtra	Kavitake P. R.	Dr. V. H. Nirmale
02	Compliance of fisheries subsidies in India to the code of conduct for responsible fisheries	Pandey A	Dr.R.A.Pawar
03	Traditional knowledge in management of wild freshwater prawn seed collection from North Konkan region of Maharashtra	Shinde S.A	Shri.B.P.Bhosale
2022			
01	A study on seasonal changes in feeding habit and reproductive biology of sciaenid species from Ratnagiri coast, Maharashtra, India.	Mehta P.	Dr. S. A. Mohite

02	A comparative analysis of the fish food balance sheets of top fish producing nations of Asia	Rathod K. B.	Dr. R.A. Pawar
03	Studies on biology of obtuse barracuda, <i>Sphyraena obtusata</i> (Cuvier 1829), from Ratnagiri coast	Ranaware S. D.	Shri. B. P. Bhosale
04	Biological studies on cleft belly trevally <i>Atropus Atropus</i> (Bloch and Schneider, 1801) from Ratnagiri coast	Rakhunde A. V.	Dr. V.H.Nirmale

FISH BIOTECHNOLOGY

2012

01	Molecular Discrimination of Six Mullet Species From Ratnagiri Coast Using Random Amplified Polymorphic DNA (RAPD) Markers	Miss. NadkarPranita G.	Dr.M. S Sawant Dr. P. D. Redekar Dr. S. K. Barve Shri.
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2013

01	Molecular Identification of Marine Clams of Family Veneridae from Ratnagiri Using Random Amplified Polymorphic DNA (RAPD) Analysis	KendreMeena B.	Dr.M.S. Sawant Dr.R.A.Pawar
02	Morphometric and Molecular Studies on Three Portunid Crabs Off Ratnagiri Coast	BhosaleMangesh M.	Dr.R.A.Pawar Dr.M.S. Sawant
03	Molecular Identification of Oyster Species Using Random Amplified Polymorphic DNA (RAPD) Analysis	Miss. SalviPooja V.	Dr.M.S. Sawant Dr.S.D.Naik
04	Effect of Biotechnological Inputs on Crustacean Health and Water Condition	Miss. GaikwadUjwala R.	Dr.R.A.Pawar Dr.M.S. Sawant Dr. A. S. Pawase

Dr.S.D.Naik

2014

01	Karyotypes and Chromosome Variations in Edible Venerid Clams Along Ratnagiri Coast Maharashtra	Shaikh Abdul Lateef Shaikh Abdul Hakeem	Dr.(Mrs)S.A.Mohite Dr.S.D.Naik Dr. A. D. Adsul
02	Some Aspects of Bycatch and Discards in Marine Fisheries of Ratnagiri	Kadam Dipesh N.	Dr.R.A.Pawar Dr.S.D.Naiks Dr.M.S. Sawant

2015

01	Effect of Probiotics on Health Indices of Koi Carp and Goldfish	Miss. Deshmukh Pranita D.	Dr.R.A.Pawar Dr.Milind Sawant Dr.D.I.Pathan
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2016

	DNA barcoding of some common Endemic Ichthyofauna of Northern Western Ghats	Qayoom, Ubaid	Pawar, R. A. Sawant, M.S. Mohite, S. A.
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2018

01	Inter-Species Hybridisation Among Molly (<i>Poecilia</i> Spp)Species	Naik Ketan S.	Sawant, M. S. Pawar, R. A. Nirmalw V. H. Bhosale, B.
02	Molecular taxonomy of penaeid shrimps along Maharashtra coast	Dhawade A. R.	Dr. R. A. Pawar Dr. V. H. Nirmale Dr. M. S. Sawant Shri.
03	Spatio-Temporal metagenomic profiling of bacterial diversity of Aquaculture sediments	Chacharkar U. S.	Dr. R. A. Pawar Dr. S. A. Mohite Dr. M. S. Sawant Dr. V. H. Nirmale
04	Molecular taxonomy of Mudskippers along Maharashtra coast	Salunkhe N. M.	Dr. R. A. Pawar Dr. N. H. Nirmale Dr. M. S. Sawant Dr.
05	Induced moulting of Mud crab by spinach extract for producing soft shell	Shahare A. N.	Dr. S. D. Naik Dr. S. A. Mohite Shri. B. P.
2019			
01	Study on Karyotype of Freshwater Crab, <i>Barytelphusa Spp.</i>	PadyarSuchita, M.	Naik, S. D. Mohite, S. A. Pagarkar, A. U. Rather M. A.
02	Comparative genomics of fish genome for identification of candidate genes using In Silico approach	Shri. S.S. Randhawa	Dr. R.A.Pawar
03	<i>IN SILICO</i> Characterization, Homology Modelling and Structure-Based functional Annotation of <i>Labeo rohita</i> growth hormone receptor protein	DhandareBhushan C.	Bhosale, B.P. Rather, M. A.
2020			
01	Study of anti - microbial activities of extracts from marine sponge, <i>Hyrtios cavernosus</i> (Vacelet, Vasseur & Levi, 1976) from Ratnagiri coast.	Pawaskar D. K	Dr.S.A.Mo hite
2021			
01	In silico characterization, homology, modelling and structure- based functional annotation of <i>Labeo rohita</i> TLR4 protein	Golwankar A.P	Dr.R.A.Pawar
01	Comparative study of karyotypes and chromosome variations in mud crab species found along Ratnagiri coast, Maharashtra	Majik, S G.	Dr.S.A.Mo hite
2022			
01	Study of mitotic chromosomes of green chromide, <i>Etroplus suratensis</i> (Bloch 1790) from Ratnagiri coast.Maharashtra,India.	Pravallika T.	Dr.S.Mohite
01	Seaweed health benefits : A meta analysis	Naik S.B.	Dr.R.A.Paw ar

			Pagarkar A. U.
PHD	FRM		
2016			
01	Comparative Biological Studies on Bivalves of Mirya and Aare-Ware Rocky Shores of Ratnagiri, Maharashtra, India	Pakhmode, Pallavi K.	Mohite S. A. Naik , S. D. Pawar R. A. Adsul,
2018			
01	Evaluating Marine Capture Fisheries of Ratnagiri with respect to Ecosystem- based Indicators	Kolhe Suraj, S.	Pawar, R. A. Mohite,S. A. Nirmale, V. H. Sawant, M. S. Shidhankar, M.
2019			
01	Ethnoecological studies on Common Brackish Water Fishes along the South Kokan Coast of Maharashtra	Uskelwar, Laxman,S.	Sawant, M. S. Pawar, R. A. Nirmale, V. H. Pawase, A. S. Metar, S. Y.
2023	Taxonomic evaluation of fishes of the family Mugililidae	Kokate Amit A	Naik S.D

2.3. LIST OF M.F.SC. (FISHERIES RESOURCES MANAGEMNT) THESIS

2008			
01.	Systematic and Biology of Estuarine Crab <i>Scylla spp.</i> Of Ratnagiri Coast, Maharashtra	Funde Anil B.	Dr.S.D. Naik
02	Biology of <i>Sardinella Longiceps</i> along Ratnagiri Coast off Maharashtra.	Deshmukh Abhay V.	Dr. S. R. Kovale
2010			
01.	Biology of <i>Nemipterus Japonicus</i> along the Ratnagiri Coast off Maharashtra	Suresh Kumar P.S.	Dr.S.AMohite
2011			
01	Morphometrics, Gonad Development and Food and Feeding of the White Fish <i>Lactarius lactarius</i> (Bloch & Schneider, 1801)	Akhade Roshan R.	Dr. M.S Sawant.
2012			
01.	Biology of <i>Megalaspis cordyla</i> (Linnaeus, 1758) off Ratnagiri Coast, Maharashtra.	JadhavTrupti D.	Dr.S.AMohite
02.	Reproductive Biology of Estuarine Crab, <i>Scylla tranquebarica</i> (Fabricius, 1798) along Ratnagiri Coast, Maharashtra.	Sonawane Shivam S.	Dr. S.D.Naik
03	Biological Studies of Indian Mackerel, <i>Rastrelligerkanagurta</i> (Cuvier, 1817) off Ratnagiri Coast, Maharashtra.	Bhendarkar M.P.	Dr. S.D.Naik
04	Morphology and Biology of <i>Meretrix meretrix</i> (Linnaeus, 1758) along Ratnagiri Coast, Maharashtra.	Sawant Prajwala P.	Dr. (Mrs.)S.A. Mohite
05	Molecular discrimination of six Mullet species from Ratnagiri coast using random amplified polymorphic DNA (RAPD) markers	Nadkar P. G.	Dr. M. S. Sawant
2013			
01	Biology of <i>Lepturacanthus savala</i> (Cuvier, 1829) Off Ratnagiri Coast, Maharashtra	Miss. Pakhmode Pallavi K.	Dr. (Mrs.)S.A. Mohite
02	Biology of Pony Fish, <i>Leiognathus splendes</i> (Cuvier,1829) Ratnagiri Coast, Maharashtra	Acharya Kanishka V.	Dr.S.D. Naik
03	Studies on the Biology of Squid <i>Loligo duvauceli</i> (D'Orbigny,1835) along the Ratnagiri Coast of Maharashtra	Pawar Nitin S.	Shri. B. P. Bhosale
04	Morphometric and Genetic Analysis of Pink Perch <i>Nemipterus japonicus</i> Along the West Coat of India	Hakim Mudasir Maqsood	Dr.M.S. Sawant
05	Molecular identification of Oyster species using random amplified Polymorphic DNA (RAPD) analysis	SalviPooja V.	Dr. M. S. Sawant
06	Morphometric and molecular studies on three Portunid Crabs off Ratnagiri coast	BhosaleMangesh M.	Dr. R.A. Pawar

07	Effect of biotechnological inputs on Crustacean health and water condition	Gaikwad U. R.	Dr.R. A. Pawar
2014			
01	Study of Sexual dimorphism in mantis shrimp	Benjamin Kondowe	Dr.R.A.Pawar
02	Bionomics of Freshwater Crab Resources of Ratnagiri with reference to <i>Barytelphusa cunicularis</i> (Wesrwood,1836)	Beg Nayum A.	Dr.S.D.Naik
03	Studies on the Biology of Pony Fish <i>Leiognathus bindus</i> (Valenciennes,1835) along the Ratnagiri Coast of Maharashtra	Biswajit Borah	Dr. V. H. Nirmale Dr. R. A. Pawar Shri. B. P. Bhosale Sr. S. Y. Metar
04	Studies on the Biology of Indian Sand Whiting <i>Sillagosinham</i> (Forsskal,1175) along the Ratnagiri Coast of Maharashtra	Sawant Prutha P.	Shri. B. P. Bhosale Dr. S. D. Naik Dr.V.H. Nirmale Dr. S. Y. Metar
2015			
01	Indigenous Knowledge in Management of Stake net Fishery (Wan) along the Ratnagiri Coast of Maharashtra	Uskelwar Laxman S.	ShriB.P.Bhosale
02	Studies on the Biology of Tiny Shrimp <i>Parapenaeopsis stylifera</i> (Edwards,1837) of Ratnagiri Coast of Maharashtra	Miss. RawangaveRekha S.	Dr.S.D.Naik
03	Biological Studies of Blood Clam <i>Tegillarca (Anadara) rhombea</i> (Born,1778) along Ratnagiri Coast, Maharashtra	Miss.Meshram Asawari M.	Dr.(Mrs)S.A.Mohite
04	Studies on the Biology of Malabar Tongue Sole <i>Cynoglossus macrostomus</i> (Norman,1928) Along the Ratnagiri Coast of Maharashtra	Miss. Bhalekar Pooja V.	Dr.V.H.Nirmale
05	Study of Sexual Size Dimorphism in Mantis Shrimp	Kondowe Benjamin N.	Dr. R. A. Pawar
2016			
01	Biological studies on moustached Thryssa, <i>Thryssa mystax</i> (Schneider, 1801) along the Ratnagiri coast of Maharashtra	Kende D. R.	Dr. V. H. Nirmale
02	Morphometrics, Food and feeding and reproductive biology of white sardine, <i>Escualosa thoracata</i> (Valenciennes, 1847) of Ratnagiri Coast	Gurjar U. R.	Dr. M. S. Sawant
03	Studies on Capture Fisheries of Krishna River in Sangali District of Maharashtra	KokateAmit A.	Bhosale, B. P.
04	Study of Spatio-Temporal Variations in the Sponge of Ratnagiri Coast, Maharashtra, India	Shishir Kumar	Mohite S. A.
2017			
01	Truss morphometric analysis of Great Clam <i>Meretrix meretrix</i> from Ratnagiri, Maharashtra, India	Miss DarokarSheetal R.	Dr. Mrs. S. A. Mohite

02	Biological Studies on dussumier's Thryssa, <i>Thryssa dussumieri</i> (Valenciennes, 1848) along the Ratnagiri coast of Maharashtra	Pawase Sudarshan V.	Dr.V.H.Nirmale
03	Identification of Finfish Seed and its seasonal variation along the Kasarveli Estuary of Ratnagiri Coast of Maharashtra	Balkate Jayesh J.	Naik, S. D.
2019			
01	Biological studies on the Shrimp Scad, <i>Alepes djedaba</i> (Forsskal, 1775) along the Ratnagiri coast of Maharashtra	Bandkar D. S.	Dr. V. H. Nirmale
02	Biological studies on the Jinga Shrimp <i>Metapenaeus affinis</i> (H. Milne Edwards, 1837) along Ratnagiri coast of Maharashtra	Dongre S. J.	Dr. S. Y. Metar
03	Taxonomic evaluation of species of the family Leiognathidae along the coast of Maharashtra	Godavarikar A. M.	Dr. S. S. Gangan

2.5. LIST OF M.F.Sc. (FISH BIOTECHNOLOGY) THESIS

SR. NO.	YEAR	TITLE OF THE THESIS	NAME OF THE STUDENT	GUIDE & CHAIRMAN, SAC
Degree awarded				
1	2012	Molecular discrimination of six mullet species from Ratnagiri coast using Random Amplified Polymorphic DNA(RAPD) markers	Miss. P.G. Nadkar	Dr. M.S. Sawant
2	2013	Morphometric and molecular studies on three Portunid crabs off Ratnagiri coast	Shri. M.M.Bhosale	Dr. R.A.Pawar
3	2013	Effect of biotechnological inputs on crustacean health and water condition	Miss. U.R.Gaikwad	Dr. R.A.Pawar
4	2013	Molecular identification of oyster species using Random Amplified Polymorphic DNA(RAPD) analysis	Miss. P.V. Salvi	Dr. M.S. Sawant
5	2014	Molecular identification of marine clams of Family Veneridae from Ratnagiri using Random Amplified Polymorphic DNA(RAPD) analysis	Miss. M.B.Kendre	Dr. M.S. Sawant
6	2014	Karyotyping and chromosomes variations in edible Veneridae clams along Ratnagiri coast, Maharashtra	Shri. Shaikh A.L.S.A.Hakim	Dr. S.A.Mohite
7	2014	Morphometric and genetic analysis of Pink Perch, <i>Nemipterus japonicus</i> along the west coast of India	Shri. Hakim M.M.	Dr. M.S. Sawant

8	2015	Effect of probiotics on health indices of Koi carp and Goldfish	Miss. P. D. Deshmukh	Dr. R.A.Pawar
9	2018	Molecular taxonomy of penaeid shrimps along Maharashtra coast	Miss. A.R.Dhawade	Dr. R.A.Pawar
10	2018	Inter-species hybridization among molly (<i>Poecilia spp.</i>) species	Shri. K.S.Naik	Dr. M.S. Sawant
11	2018	Molecular taxonomy of mudskipper along Maharashtra coast	Shri. N.M.Salunke	Dr. R.A.Pawar
12	2018	Induced molting of mud crab by spinach extract for producing soft shell	Shri. A.N.Shahare	Dr. S.D.Naik
13	2018	Spatio-temporal metagenomic profiling of bacterial diversity of aquaculture sediments	Shri. U.S. Chacharkar	Dr. R.A.Pawar
14	2019	Study on karyotyping of freshwater crab <i>Barytelphusa spp.</i>	Miss. S.M.Padyar	Dr. S.D.Naik
15	2019	Comparative genomics of fish genome for identification of candidate genes using <i>In Silico</i> approach	Shri. S.S. Randhawa	Dr. R.A.Pawar
16	2019	<i>In Silico</i> characterization, homology modelling and structure - based functional annotation of <i>Labeo rohita</i> growth hormone receptor protein	Shri. B.C. Dhandare	Shri. B.P. Bhosale
17	2020	Study of anti - microbial activities of extracts from marine sponge, <i>Hyrtios cavernosus</i> (Vacelet, Vasseur & Levi, 1976) from Ratnagiri coast.	Shri. D.K. Pawaskar	Dr. S.A.Mohite

2.6. LIST OF Ph.D. (FISHERIES RESOURCES MANAGEMNT) THESIS

2016				
01	Comparative Biological Studies on Bivalves of Mirya and Aare-Ware Rocky Shores of Ratnagiri, Maharashtra, India	Pakhmode, Pallavi K.	Mohite S. A.	
2018				
01	Evaluating marine capture fisheries of Ratnagiri with respect to Ecosystem- based Indicators	Kolhe Suraj, S.	Pawar, R. A.	
2019				
01	Ethnoecological studies on Common Brackish Water Fishes along the South Kokan Coast of Maharashtra	Uskelwar, Laxman,S.	Sawant, M. S.	

3.1. Research:

Apart from some collaborative research work conducted, the department has to date completed many research projects of which five are externally funded by various agencies like ATMA, Rajiv Gandhi Science & Technology Commission, Govt. of Maharashtra, National Agriculture Innovative Projects and National Fisheries Development Board. Department has many recommendations approved by the Joint AGRESCO to its credit. Two externally funded projects are currently going on.

The departmental research work addresses some major areas of importance or concern such as biodiversity assessment, clam resources, mud crabs, specimen preservation, by-catch and fishing of non-target fish species, stock assessment and population dynamics.

3.2. Ongoing research projects

Sr. No.	Title of the project	Principal Investigator/ Co-Investigator
1	Ethnotaxonomy of estuarine ichthyofauna along the Ratnagiri coast of Maharashtra	Dr. V.H.Nirmale (P.I.) Dr. R.A.Pawar (Co-P.I.)
2	Economic impact of juvenile fishing on some selected species (<i>Uroteuthis duvauceli</i> and <i>Sardinella longiceps</i>)	Dr. V.H.Nirmale (Co-P.I.) Dr. R.A.Pawar (Co-P.I.)

4. Extension:

The department has conducted various extension program for the fishermen, fish farmers and also for school students. Awareness programs pertaining to Endangered aquatic species, monsoon ban on fishing, freshwater prawn farming etc. were conducted by the department in campus as well as at Harnai, Guhagar, Vengurla, Malvan, Purnagad, Adiwale, Mirkarwada, Karla and Agar Naral villages.

The department has also published many news articles, extension booklets, pamphlets, glossary and handbooks related to the topics such as biodiversity, mangroves, sponges and other marine organisms etc.

5. Amenities and laboratories:

U.G. Laboratory & museum:

The department has a spacious laboratory for conducting the U.G. practicals. The laboratory can accommodate about 25 students at a time with sufficient working space for each student. Similarly, the department has a well-equipped laboratory for P.G. students.

A well-arranged museum has been maintained by the department. Preserved specimens of more than 250 fresh water, brackish water and marine fishes, shellfishes and other aquatic animals are displayed here. The museum has recently acquired taxidermy specimens of some aquatic animals. The museum also has many shellfish specimens collected from all over India. The museum has been attracting students as well as tourists.

Dr. S.A.Mohite				
Sr. No.	Author/s	Title of the paper	Journal	Volume/year/N AAS Rating
1	Mohite S.A., H. Singh and A.S.Mohite	Study of culture of the shortneck clam <i>Paphia malabarica</i> in kalbadevi estuary (Ratnagiri), west coast of India	Indian Journal of Applied and Pure Biology	2008, 23 (1), 153-160 ISSN 0970-2091
2	Mohite S.A.	Status of fisherwomen co-operative societies in Ratnagiri district	Fishing Chimes	2008, 28 (1), 131 -135, ISSN 0971 -4529
3	Mohite S.A. and A.S. Mohite	Seasonal variations in the proximate composition of <i>Paphia malabarica</i> (Chemnitz) from estuarine regions of Ratnagiri, west coast of India	Geobios	2008, 35 (2-3), 121-128 ISSN 0251 -1223
4	Mohite S.A. and A.S. Mohite	On condition index and percentage edibility of the Shortneck clam <i>Paphia Malabarica</i> (Chemintz) from estuarine regions of Ratnagiri, West coast of India	Aquaculture Research Journal, (Blackwell Publications)	2009, 40, 69-73 Online ISSN: 1365-2109 Print ISSN: 1355-557X 7.32
5	Mohite S.A. and A.S. Mohite	Resource potential study of <i>Paphia Malabarica</i> of Kalbadevi estuary (Ratnagiri, Maharashtra)	Indian Journal of Applied and Pure Biology	2008, 23 (2), 349-356 ISSN 0970-2091
6	Mohite S.A. and A.S. Mohite	Prospects of genetic transformation techniques in the culture of marine molluscs in India	Nature Environment & Pollution Technology	2008, 7 (3): 435 - 439, ISSN 0972 - 6268 4.94
7	A.S. Mohite and S.A.Mohite	Length-weight relationship of ribbonfish, <i>Trichiurus lepturus</i> of Maharashtra coast, India	Geobios	2008, 35(4), 269 - 274, ISSN 0251 -1223
8	Mohite S.A. and A.S. Mohite	Marketing of fish and fisheries products: Dominant role of women	Fishing Chimes	2008, 28 (8), 35 -38, ISSN 0971 -4529

9	A. S. Mohite and S. A. Mohite	Study of stocks of ribbon fish <i>Trichiurus lepturus</i> from different landing centers of Maharashtra	Aquacult	2008, 9(2), 113-119, ISSN 0972 - 2262
10	Mohite S.A. and A.S. Mohite	Age and growth of the shortneck clam, <i>Paphia malabarica</i> (Chemintz) in estuarine areas of Ratnagiri, West Coast of India	Asian Journal of Animal Science	Dec.,2008 – May 2009, 3 (2): 235 – 240ISSN 0973 – 4791 3.4
11	A. S. Mohite, S. A. Mohite and R.S.Biradar	Age and growth of <i>Trichiurus</i> <i>lepturus</i> (Linnaeus, 1758) off Konkan coast, Maharashtra, India	Asian Journal of Animal Science	Dec.,2008 – May 2009, 3(2): 120 - 123ISSN 0973 – 4791 3.4
12	Mohite S.A. and A.S. Mohite	Comparative study of the toxic effects of selected pesticides on common carp spawn	Indian Journal of Applied and Pure Biology	2009, 24(01), 147– 154 ISSN 0970- 2091
13	A. S. Mohite and S. A. Mohite	Effect of dietary protein level on growth and survival of carp spawn	Indian Jour. of Applied and Pure Biology	2009, 24 (01), 63 – 71 ISSN 0970- 2091
14	Mohite S.A. and A.S. Mohite	Morphometric relationship of length and weight of <i>Paphia</i> <i>malabarica</i> according to sexes	Geobios journal	2009, 36(1), 25 - 28, ISSN 0251 - 1223
15	A.B. Funde, S. D. Naik, S.A. Mohite , G.N. Kulkarni and A. V. Deshmukh	Food and feeding habits of mudcrab <i>Scylla</i> spp. Of Ratnagiri coast, Maharashtra	Ecology and Fisheries	2009, 1 (1): 43 – 50, ISSN 0974 – 6323
16	Mohite S.A. and A.S. Mohite	Scope of women self help groups and co-operative societies in fishery sector in India	Fishing chimes	2009, 29 (1), 177 – 180 ISSN 0971 – 4529
17	A.B. Funde, S. D. Naik, S.A. Mohite	Catch particulars of <i>Scylla</i> spp. of Ratnagiri	Aquacult	2009, 10 (1), 17 – 25, ISSN 0972 - 2262

18	A.B. Funde, S. D. Naik, S.A. Mohite,	Contribution to the biology of the mudcrab, <i>Scylla serrata</i> of Ratnagiri, Maharashtra	Aquacult	2009, 10 (1), 73 – 79, 2009 ISSN 0972 - 2262
19	M. J. Tike, J. S. Samant and S. A .Mohite	Diversity status of minor fish and shellfish of Malvan coast, Maharashtra	Indian Journal of Applied and Pure Biology	209, 24(2), 441 – 448 ISSN 0970- 2091
20	Mohite S.A. and A.S. Mohite	Study of salinity tolerance of <i>Paphia malabarica</i> subjected to varying salinity levels	Geobios	2009, 36(4), 289 – 294, ISSN 0251 - 1223
21	S. A. Mohite and A. S. Mohite	Spawning response in relation to ecological stimuli and geographical locations in the shortneck clam <i>Paphia malabarica</i>	Journal of Marine Biological Association of India	2009, 51 (2), 164 – 172, ISSN 0025- 3146 4.84
22	Mohite S.A. and A.S. Mohite	Gonadal developments in relation to the ecology in the shortneck clam <i>Paphia malabarica</i> in estuarine environment of Ratnagiri, west coast of India	World Review of Science, Technology and Sustainable Development	2010, 7(4), 341 – 351, ISSN online 1741-2234 ISSN print 1741-2242
23	Mohite S.A. and A.S. Mohite	Allometric Relationships in The Shortneck Clam <i>Paphia malabarica</i> (Chemintz) from estuarine areas of Ratnagiri, India	Biosciences Biotechnology Research, Bhopal	2010, 7 (1), 153 – 158, ISSN: 0973- 1245 THOMSON REUTERS, USA IC VALUE 9.00
24	Mohite A. S., S. A. Mohite and R. S. Biradar	Stock Assessment of Indian Ribbonfish <i>Trichiurus lepturus</i> along Maharashtra coast, India	Geobios	2011, 38 (1), 3 - 8, ISSN 0251 - 1223
25	P. S. Suresh Kumar, S. A. Mohite, S. D. Naik and A. S. Mohite	Length weight relationship in <i>Nemipterus japonicas</i> of Ratnagiri coast along Maharashtra	Indian Journal of Applied and Pure Biology	2011, 26 (1), 79 – 84, ISSN 0970- 2091

26	Mohite S.A. and A.S. Mohite	Study of <i>Paphia malabarica</i> (Chemnitz) from Kalbadevi estuary, India, exposed to hydrogen sulphide	Pollution Research	2010, 29 (4): 655 – 658 3.3
27	P. S. Suresh Kumar, S. A. Mohite , S. D. Naik and A. S. Mohite	Length frequency analysis of <i>Nemipterus japonicus</i> along the Ratnagiri coast off Maharashtra	Geobios	2011, 38(4), 229 – 232, ISSN 0251 - 1223
28	P. S. Suresh Kumar, S. A. Mohite	Study of relationships between the morphometric characters of the threadfin bream, <i>Nemipterus japonicus</i>	Biosciences Biotechnology Research Asia	2011, 8(2): 685 – 691, ISSN: 0973-1245 THOMSON REUTERS, USA IC VALUE 9.00
29	P. S. Suresh Kumar, S. A. Mohite	Study of food and feeding habit in <i>Nemipterus japonicus</i> along the Ratnagiri coast off Maharashtra	Ecology and Fisheries	2012, 5(1), 1-10, ISSN 0974 - 6323
30	Mohite S.A. and A.S. Mohite	Resource analysis of venerid clams along the south-west coast of Maharashtra.	The Asian Journal of Animal Sciences	2012, 7(1), 27-35, ISSN:0973-4791 3.4
31	Bhendarkar, M.P., Naik, S.D. Mohite, S.A. , Kulkarni, G.N.	Reproductive biology of Indian mackerel, <i>Rastrelliger kanagurta</i> (Cuvier, 1817) off Ratnagiri coast, Maharashtra, India	Discovery Science journal	2013, 3(9), 24-26, ISSN 2278 – 5485 EISSN 2278 – 5477
32	Jadhav, T.D., Mohite, S.A.	Length frequency analysis of torpedo trevally, <i>Megalaspis cordyla</i> along Ratnagiri coast, Maharashtra, India	Indian Journal of Science (Discovery)	2013, 2(5), 109-111, ISSN-2319 - 7730
33	Jadhav, T.D., Mohite, S.A.	Morphometry and length-weight relationship of <i>Megalaspis cordyla</i> (Linnaeus, 1758) off Ratnagiri coast, Maharashtra	Indian Journal of Applied and Pure Biology	2013, 28 (2), 197 – 201, ISSN 0970-2091

34	Jadhav, T.D., Mohite, S.A	On Ova-diameter study in the horse mackerel, <i>Megalaspis cordyla</i> (Linnaeus, 1758) along the south-west coast of India	Asian Journal of Animal Science	2013, 8 (1),16 – 19, ISSN:0973-4791 3.4
35	Jadhav, T.D., Mohite, S.A	Feeding biology of the Horse mackerel <i>Megalaspis cordyla</i> (Linnaeus, 1758) off Ratnagiri coast, Maharashtra	Asian Journal of Marine Science	2013, 1 (1), 1-6, ISSN 2347-8160
36	Sawant P.P., Mohite, S.A.	Length frequency analysis of the great clam, <i>Meretrix meretrix</i> along south west coast of Maharashtra, India	Discovery journal	2013, 4(10), 19-21, ISSN 2278 – 5469 EISSN 2278 – 5450
37	Sawant P.P., Mohite, S.A.	Study of allometric relationships in the great clam, <i>Meretrix meretrix</i> (Chemnitz) from the south west coast of India	Discovery Science journal	2013, 4(11), 22-24, ISSN 2278 – 5485 EISSN 2278 – 5477
38	Sawant P.P., Mohite, S.A.	Study of proximate composition of <i>Meretrix meretrix</i> (Linnaeus, 1758) of the Ratnagiri coast, Maharashtra, India	Biosciences Biotechnology Research Asia	Vol. 10(1), 311-317, 2013 ISSN: 0973-1245 THOMSON REUTERS, USA IC VALUE 9.00
39	Sawant P.P., Mohite, S.A.	Reproductive development in estuarine clam, <i>Meretrix meretrix</i> along the south west coast of Maharashtra, India	Asian Journal of Biological and Life Sciences	2013, 2 (2), 100-106, ISSN 2278-747X
40	Sawant P.P., Mohite, S.A.	Length weight relationship in the great clam, <i>Meretrix meretrix</i> along south west coast of Maharashtra, India	Geobios journal	2013, .40 (2-3), 155 – 164, ISSN 0251 - 1223

41	V.P.Joshi, S.D.Naik, Bhendarkar, M.P., S.A.Mohite	Occurrence of ocean sunfish <i>Mola mola</i> (Linnaeus) in the coastal waters off Ratnagiri, Maharashtra	Fishing chimes	2013, 32 (12), 55, 2013 ISSN 0974 – 6323
42	Pakhmode P.K., Mohite S.A. , Mohite A.S.	Morphological characters and morphometric relationship of ribbonfish, <i>Lepturacanthus</i> <i>savala</i> (Cuvier, 1929) off Ratnagiri coast, Maharashtra	Species , Discovery Journal	2013, 5(14), 18-22, ISSN 2319- 5746 EISSN 2319- 5754
43	Pakhmode P.K., Mohite S.A. , Naik SD, Mohite AS.	Length frequency analysis and length-weight relationship of ribbonfish, <i>Lepturacanthus</i> <i>savala</i> (Cuvier, 1829) off Ratnagiri coast, Maharashtra	International Journal of Fisheries and Aquatic Studies	2013, 1 (2): 25-30, ISSN:2347- 5129
44	Tekade AS. Kulkarni GN, Mohite SA.	Influence of fly ash on soil characteristics of Kharland pond, Ratnagiri (Maharashtra)	Discovery Agriculture	2013, 1(2), 62-66, ISSN 2347- 3819 EISSN 2347- 386X
45	Jadhav, T.D., Mohite, S.A.	Reproductive biology of Horse mackerel <i>Megalaspis cordyla</i> (Linnaeus, 1758)	Jour. Marine Biological Association of India	2013, 55 (2), 35-40 ISSN - 0025- 3146(Print) ISSN - 2321- 7898 (Online) 5.40
46	Joshi V.P., Mohite S.A. , Satam S.B.	On the occurrence of the deepsea snake fish, <i>Acanthocephala limbata</i> (Cuvier) (Pisces: Cepolidae) along Ratnagiri coast, Maharashtra, India	Discovery Species	2014, 7(17), 17-19 ISSN 2319- 5746 EISSN 2319- 5754
47	Pakhmode P.K., Mohite S.A. ,	Feeding biology of ribbonfish, <i>Lepturacanthus savala</i> (Cuvier, 1929) off Ratnagiri coast, Maharashtra	International Journal of Fisheries and Aquatic Studies	2014; 1(3): 123-129 ISSN:2347- 5129

48	S.A. Mohite, Sawant P.P.	Traditional bivalve culture practices along the Ratnagiri coast of Maharashtra, India	Discovery Agriculture	2014, 2(3), 3- 8 ISSN 2347-3819 EISSN 2347-386X
49	Shaikh A.L.A.H. and Mohite S.A.	Study of chromosome morphology of venerid clam <i>Paphia malabarica</i>	Discovery Science	2015, 11(24), 8-15 ISSN 2278 – 5485 EISSN 2278 – 5477
50	Pakhmode P.K., Mohite S.A.,	Reproductive biology of the Ribbonfish, <i>Lepturacanthus savala</i> (Cuvier, 1829)	International Journal of Science and Applied Research	2015, 2(7); 61-76 ISSN NO. 2394-2401 (online) ISSN NO. 2394-384X(online)
51	Mohite S.A. and Meshram A.M.	On Haematological Characteristics of Blood Clam, <i>Tegillarca rhombea</i> (Born, 1778)	Journal of Aquaculture & Marine Biology (MedCrave Group LLC. Publication, USA)	2015, 3(2): 00065. DOI: 10.15406/jamb.2015.03.00065 ISSN: 2378-3184
53	K.M.Sandhya, S.K.Charaborty, A.K.Jaiswar, T.Kumar and S.A.Mohite	Morphometry and length-weight relationship of <i>Otolithes cuvieri</i> (Trewavas, 1974) from Ratnagiri waters, Maharashtra, north-west coast of India	Indian Journal of Fishery	2015, 62 (4): 99-103, ISSN 0970-6011 6.59
53	Pakhmode P.K., and Mohite S.A.	Study of gonad development using ova diameter analysis in ribbonfish, <i>Lepturacanthus savala</i> (Cuvier, 1829)	IOSR Journal of Agriculture and Veterinary Science (IOSR-JAVS)	e-ISSN: 2319-2380, p-ISSN: 2319-2372. Volume 9, Issue 2 Ver. I (Feb. 2016), Pp. 01-05 1.739

54	Pakhmode P.K. and Mohite S.A.	Study of hydrological parameters off Mirya and Aare-Ware Rocky shores of Ratnagiri, Maharashtra India	Journal of Experimental Zoology	2016, 19 (2), 1087-1092, ISSN: 0972-0030 5.25
55	Shaikh A.L.A.H. and Mohite S.A.	Study of chromosome morphology of venerid clam <i>Paphia textile</i>	Journal of Indian Society of Genetics, Biotechnology Research and Development	8(3) : 194 - 201 (Aug. 2016) ISSN Print: 2277-1913 ISSN Online: 2249-7498 3.4
56	Salvi P.V. and Mohite S.A.	Molecular identification of oyster species using Random Amplified Polymorphic DNA [RAPD] analysis	Journal of Indian Society of Genetics, Biotechnology Research and Development	2016, 8(3) : 176-182 ISSN Print: 2277-1913 ISSN Online: 2249-7498 3.4
57	Meshram A.M, Mohite S.A.	Morphometric Study of Blood Clam, <i>Tegillarca rhombea</i> (Born, 1778).	Journal of Fisheries and Livestock Production Journal h-index : 22 Journal cite score : 8.44 Journal impact factor : 6.04	4:179. doi: 10.4172/2332 - 2608.1000179 ISSN : <u>2332-2608</u>
58	S.S. Belsare , Hukam Singh Dhaker, A.S. Pawase, V.R. Joshi, S.A. Mohite and S. Shelke	Effect of Dietary Carbohydrate - Lipid Ratio on Growth, Body Composition and Digestive Enzyme Activities of Juvenile Goldfish (<i>Carassius auratus</i>)	Animal Nutrition and Feed Technology	2017, 17 : 43-53 DOI: 10.5958/0974 - 181X.2017.0005.1 ISSN: 0972-2963 6.25

59	S.S. Belsare , Hukam Singh Dhaker, A.S. Pawase, V.R. Joshi, S.A. Mohite and R.H. Rathod	Effects of dietary protein and lipid levels on growth, feed utilization and body composition in juvenile goldfish, <i>Carassius auratus</i>	Indian Journal of Animal Research	DOI:10.18805/ijar.v0iOF.7816 (1-7) Print ISSN:0367-6722 / Online ISSN:0976-0555 6.09
60	P. K. Pakhmode, S. A. Mohite, S. D. Naik, R. A. Pawar & A. D. Adsul	Allometric relationship of shortneck clam <i>Paphia malabarica</i> (Chemnitz, 1782) along Aare-Ware rocky shore of Ratnagiri, Maharashtra	Journal of Indian Society of Genetics, Biotechnology Research and Development	9(1) : 66-72 (2017) 3.4
61	Ubaid Qayoom, R.A.Pawar, S.A.Mohite, M.S.Sawant, V.H.Nirmale, S.P.Pawar, M. Goswami and W.Lakra	DNA barcoding of some commonly exploited fishes from the northern Western Ghats, India	Indian journal of Animal Sciences	2018, 88 (2): 245-250 ISSN: 0367-8318 6.29
62	S. Shah, S.B. Patange, S. D. Meshre, J.M. Koli, S.D. Naik, M.S. Sawant and S.A. Mohite	Effects of egg white and sodium ascorbate on gelation properties of lesser sardine (<i>Sardinella spp.</i>) Surimi	Journal of Entomology and Zoology Studies	2018; 6(2): 2504-2507 ISSN: 2349-6800
63	Gaikwad B.V., Pagarkar A.U., Chogale N.D., Mohite S.A., Chaudhari K.J., Kudale A.S., Satam S.B., Bhosale B.P. and Sawant N.H.	Effect of washing processes on quality parameters of surimi prepared from Lesser sardine (<i>Sardinella spp.</i>)	Journal of Entomology and Zoology Studies	2018; 6(5): 2202-2208 ISSN: 2349-6800

64	B. V. Gaikwad, A. U. Pagarkar, N. D. Chogale, S. A. Mohite, K. J. Chaudhari, A. S. Kudale, S. B. Satam, B. P. Bhosale and N. H. Sawant	Effect of nutritional quality on frozen stored surimi prepared from lesser sardine (<i>Sardinella</i> spp.) added with different natural phenolic compounds	Journal of Experimental Zoology India	ISSN: 0972-0030 5.25
65	Shah, Sanna; Patange, S. B.; Meshre, Supriya D.; Koli, J. M.; Naik, S. D.; Sawant, M. S.; Mohite, S. A.	Effects of pomegranate peel extract on gelation characteristic of lesser sardine (<i>Sardinella</i> spp.) surimi	Journal of Experimental Zoology India	2020, 23, 811-817. ISSN: 0972-0030 5.25
66	P K Pakhmode, S A Mohite, S Takar & U R Gurjarc	Reproductive biology of rock oyster, <i>Saccostrea cucullata</i> (Born, 1778) along Aare-Ware rocky shore of Ratnagiri, Maharashtra, India	Indian Journal of Geo Marine Sciences	2021,50 (10), 802-809 ISSN: Print:2582-6727, Online:2582-6506. Impact Factor of IJMS is 0.553
67	Pooja Mehta, S. A. Mohite, T. R. A. Pawar, V. H. Nirmale and S. D. Naik	Seasonal changes in feeding habit of <i>Johnius elongatus</i> (Mohan, 1976) sciaenid species from Ratnagiri coast, Maharashtra, India	Journal of Experimental Zoology India	2023, 26 (1), 707-711, 2023 ISSN: 0972-0030 5.25
68	U. Pravallika, S. A. Mohite, R. A. Pawar, B. P. Bhosale and A. S. Mohite	Study of karyotypes of green chromid, <i>Etroplus suratensis</i> (Bloch, 1970) from Ratnagiri coast, Maharashtra, India	Journal of Experimental Zoology India	2023, 26 (1), pp. 695-697, ISSN: 0972-0030 5.25
69	Pooja Mehta, S. A. Mohite and P. B. Bagul	Reproductive biology of <i>Johnius elongatus</i> (Mohan, 1976) From Ratnagiri coast, Maharashtra, India	Journal of Experimental Zoology India	2023, 26 (2), 2077-2082, ISSN: 0972-0030 5.25

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1	Akanksha V. Rakhunde1, Vivek H. Nirmale, Ravindra A. Pawar, Santosh Y. Metar and Bhaskar P. Bhosale	Biology of the cleftbelly trevally <i>Atropus atropos</i> (Bloch and Schneider, 1801) from Ratnagiri coastof India	Ind J Fish. 70 (2): 33-40	2023
2.	D.R.Kende, V. H. Nirmale, S. Y. Metar, R. A. Pawar and	Studies on growth and mortality of Moustached <i>Thryssa</i> , <i>Thryssa mystax</i> along the Ratnagiri coast of India	Indian Journal of Geo-Marine Sciences. 47(5):1065-1068	2018
2	P.V. Bhalekar, V. H. Nirmale , S. Y. Metar, R. A. Pawar and D. R. Kende	Studies on feeding and reproductive biology of Malabar Tongue Sole, <i>Cynoglossus macrostomus</i> (Norman, 1928) along the Ratnagiri coast of India	Indian Journal of Geo-Marine Sciences. 47(6):1217-1221	2018
3	Gurjar UR, Sawant MS, Takar S, Pawar RA, Nirmale VH , Pawase AS	Reproductive biology and fishery of the white sardine, <i>Escualosa thoracata</i> (Valenciennes, 1847) from the Ratnagiri coast.	Indian Journal of Geo-Marine Sciences. 47 (12): 2485-2491	2018
4	S.S.Kolhe, U.S.Chacharkar, R.A.Pawar	Length-weight relationships of four species captured off Ratnagiri	J.App.Icthyol. 1-2	2017
5	Sawant P.P, Nirmale V.H. , Metar S.Y.,	Biology of Indian sand whiting, <i>Sillago sihama</i> along the Ratnagiri coast	Indian Journal of Geo-Marine Sciences. 46 (9): 1899-1907	2017

	Bhosale B.P., and Chogale N.D.			
6	L.S.Uskelwar, V.H.Nirmale , B.P.Bhosale	Indigenous Knowledge used in wan fishery practiced along the Ratnagiri coast of Maharashtra	J. Mar. Biol. Ass. India, 59 (2): 48-52	2017
7	Kokate A.A, Bhosale B.P., Metar S.Y., Chogale N.D., Pawar R.A., Nirmale V.H	Coparison of ichthyofaunal diversity of Sangli region of Krishna river, Maharshtra	J. Ept. Zool. Stud 5(4):292-300	2017
8	Gurjar UR, Sawant MS, Takar S, Pawar RA, Nirmale VH , Pawase AS	Biometric analysis of White sardine, <i>Escualosa thoracata</i> (Val., 1847) along the Ratnagiri coast	J. Expt. Zool. Stud Ind 20(4):845-849	2017
9	Gurjar UR, Sawant MS, Takar S, Pawar RA, Nirmale VH, Pawase AS	A study of food and feeding habits of white sardine, <i>Escuolasa thoracata</i> (Val. 1847) along the Ratnagiri coast	J. Expt. Zool. Stud Ind 20:745-762	2017
12	B.S.Borah, Nirmale V.H. , Metar S.Y., Bhosale B.P., Chogale N. D and Pawar R.A	Biology of Silverbelly, <i>Photopectoralis bindus</i> (val.1835) along Ratnagiri coast	Fishery Technology 53 : 89-95	2016
13	B.S.Borah, Nirmale V.H. , Metar S.Y., Bhosale B.P.,	Biology of Silverbelly, <i>Photopectoralis bindus</i> (val.1835) along Ratnagiri coast.	Fishery Technology.	2016 53 : 89-95

	Chogale N. D and Pawar R.A.			
14	Gangan S.S., Metar S.Y., Nirmale V.H. , Chogale N.D., Balange A.K., Bhalekar M.S and Pai.R.	Indigenous Knowledge in Management of Bivalve Fishery of South Konkan coast of Maharashtra	Indian Journal of Traditional Knowledge.	201312(1): 72-79
15	Gangan S.S., Nirmale V.H. , Metar S.Y., Chogale N.D., Pai. R., Patil S.D., Patil K.D., and Balange A.K.	Validation of Indigenous Knowledge used in Management of Bivalve Fishery of South Konkan coast of Maharashtra	Journal of Marine Biological Association of India.	2014 56(2): 35-42
16	Pawar Nitin, Nirmale V.H. , Metar S.Y., Bhosale B.P., Sawant M.S. and Naik S.D.	Age, growth and mortality studies of Indian Squid, <i>Uroteuthis duvauceli</i> (d'Orbigny) along Ratnagiri coast of Maharashtra	Indian Journal of Geo-Marine Sciences.	2015 44(1): 33-36
17	Nirmale V.H. , Chogale N.D., Metar S.Y., Gangan S.S., Pawar R.A. & Pai. R.	Validation of indigenous knowledge on edibility of baby clam, <i>Katylesia opima</i> from the Ratnagiri coast of Maharashtra	Indian Journal of Traditional Knowledge.	2016 15(1): 149-153
18	P. V. Bhalekar, V. H. Nirmale , S. Y. Metar, R. A. Pawar and D. R. Kende.	Studies on growth and mortality of Malabar tongue sole, <i>Cynoglossus macrostomus</i> (Norman, 1928) along the Ratnagiri coast of Maharashtra	J. Mar. Biol. Ass. India, 58 (1)	2016

19	Kokate A.A, Bhosale B.P., Metar S.Y., Chogale N.D., Pawar R.A., Nirmale V.H	Indigenous fishing crafts and gears of Krishna river with respect to Sangli district of Maharashtra	Int.J.Fish Aquatic studies 4(6); 434-438	2016
20	Pawar Nitin, Nirmale V.H. , Metar S.Y., Bhosale B.P., Sawant M.S. and Naik S.D	Age, growth and mortality studies of Indian Squid, <i>Uroteuthis duvauceli</i> (d'Orbigny) along Ratnagiri coast of Maharashtra.	Indian Journal of Geo-Marine Sciences. 44(1): 33-36	2015

Dr. Ravindra Pawar: Research papers published				
	Author/s	Title of the paper	Journal	Year / Volume / Impact Factor / NAAS Rating
1				
2				
3	Li Z-X, Zhang Y, Pawar R , Wang G, Lin H.	Development of an Optimized Protein Chip for the Detection of Fish Parvalbumin Allergen	Current Analytical Chemistry	2011/7(4) IF: 2.374
4	Zheng L-N, Lin H, Pawar R , Li Z-X, Li M-H.	Mapping IgE binding epitopes of major shrimp (<i>Penaeus monodon</i>) allergen with immunoinformatics tools.	Food Chemistry and Toxicology	2011/49 IF: 5.572
5	Wang B, Li Z-X, Pawar R , Wang X-F, Lin H.	PCR-Based Detection of Traces of Potentially Allergenic Soybean (<i>Glycine max</i>) in food matrices	Advanced Materials Research	2012/343-344 IF: 0.5
6	Pawar R , Zhang S-C, Liu C-S	Morphometric indices in an annual fish - Influence of age and gender	Acta Ichthyologica et Piscatoria	2012/42(4) IF: 0.91

7	Mudasir H, Sawant MS, Pawar RA , Pawase AS, Bhat FA	Stock identification of <i>Nemipterus japonicus</i> along West Coast of India	SKUAST Journal of Research	2016/18(2) NAAS 4.71
8	Bhosale MM, Mugake RR, Pawar RA , Sawant MS, Pawase AS	Multivariate techniques to differentiate portunid crabs (<i>Charybdis feriatus</i> , <i>Portunus pelagicus</i> , <i>Portunus sanguinolentus</i>) from Ratnagiri waters: A comparative study	J Exp Zoology India	2016/19(2) NAAS 5.25
9	Bhosale MM, Pawar RA , Sawant MS, Pawan Kumar, Lakra WS	Molecular characterization of portunid crabs (<i>Charybdis feriatus</i> , <i>Portunus pelagicus</i> , <i>Portunus sanguinolentus</i>) along Ratnagiri Coast, Maharashtra, India	J Exp Zoology India	20(1)/2017 NAAS 5.25
10	Bhosale MM, Pawar RA , Sawant MS, Pawase AS	Species differentiation of deep sea crabs (<i>Charybdis feriatus</i> , <i>Portunus pelagicus</i> and <i>P. sanguinolentus</i>) using conventional morphometric data off Ratnagiri Coast, India	Journal of Fisheries and Life Sciences	2017/2(1)
11	Kokate AND, Bhosale BP, Chogale ND, Metar SY, Pawar RA	Comparison of ichthyofaunal diversity of Sangli region of Krishna River, Maharashtra, India	J Entomol Zoology Studies	2017/5(4): 292-300
12	Gurjar UR, Sawant MS, Takar S, Pawar RA and others	Biometric analysis of White sardine, <i>Escualosa thoracata</i> along Ratnagiri coast of Maharashtra	J Exp Zoology India	2017/20 (2): 845–849 NAAS 5.25
13	Gurjar UR, Sawant MS, Pawar RA and others	A study of food and feeding habits of White sardine, <i>Escualosa thoracata</i> along Ratnagiri coast of Maharashtra	J Exp Zoology India	2017/20 (2): 755–762 NAAS 5.25
14	Kolhe SS, Chacharkar US, Pawar RA	Length-weight relationships of four species captured off Ratnagiri (Arabian Sea; West Coast of India)	J Appl Ichthyol	2017/1–2 IF 1.22

15	Sawant MS, Pawar RA and others	Restoration studies on some important mangrove species of Ratnagiri, Maharashtra, India	Fishing Chimes	2017/37: 37–40
16	Bhoy PC, Pawase AS, Pai R, Sawant MS, Indulkar ST, Pawar RA , Swain S	Species composition of freshwater prawn juveniles in River Amba Raigad district of Maharashtra	J Indian Fish Assoc	2017/44 (2): 31-36 NAAS 4.14
17	Chogale ND, Nirmale VH, Metar SY, Gangan SS, Pai R, Pawar RA , Singh H	Assessment of indigenous knowledge on edibility of oyster, <i>Crassostrea madrasensis</i> from the Ratnagiri coast of Maharashtra	Indian J Trad Knowledge	2018/17: 204–208 IF 1.09
18	Pawase SV, Nirmale VH, Pawar RA and others	Study on Growth and Mortality of <i>Thryssa dussumieri</i> (Valenciennes, 1848) along the Coast of Ratnagiri	Advanced Agril Technol J	2018/2: 48–52
19	Qayoom U, Pawar RA and others	DNA barcoding of some commonly exploited fishes from the northern Western Ghats, India	Indian J Anim Sci	2018/88 (2): 245–250 IF 0.29
20	Jain AR, Pawar RA and others	Ujjani Reservoir: An exemplary case of women empowerment in fisheries	Contemp Research India	
21	Bhosale MM, Pawar RA and others	Truss-based morphometric approach for the analysis of body shape in Portunid crabs	J Entomol Zoology Studies	2018; 6(2): 2641-2648
22	Kende DR, Nirmale VH, Metar SY, Pawar RA	Studies on the growth and mortality of Moustached thryssa	Indian J Geo Mar Science	2018/47: 1065–1068
23	Gurjar UR, Sawant MS, Pawar RA and others	Reproductive biology and fishery of the White sardine, <i>Escualosa thoracata</i>	Indian J Geo Mar Science	2018/47: 2485–2491
24	Bandkar DS, Nirmale VH, Metar SY, Pawar RA	Estimation of population parameters of shrimp scad, <i>Alepes djedaba</i> (Forsskål, 1775) along the Ratnagiri coast of Maharashtra, India	J Indian Fish Assoc	2016/46 (1): 67-73
25	Randhawa SS, Pawar RA	Fish genomes and their evolution under the influence of ecology	Ecological Complexity	2022/49, 100980 IF 2.969

26	Randhawa SS, Pawar RA	Fish genomes: Sequencing trends, taxonomy and influence of taxonomy on genome attributes	J Appl Ichthyol	2021/1–10 IF 1.22
27	Pooja Mehta, V. A. Mohite, W. R. A. Pawar, V. H. Nirmale and S. D. Naik	Seasonal changes in feeding habit of <i>Johnius elongatus</i> (Mohan, 1976) sciaenid species from Ratnagiri coast, Maharashtra, India	Journal of Experimental Zoology India	2023, 26 (1), 707-711, 2023 NAAS 5.25
28	X. Pravallika, S. A. Mohite, R. A. Pawar, B. P. Bhosale and A. S. Mohite	Study of karyotypes of green chromid, <i>Etroplus suratensis</i> (Bloch, 1970) from Ratnagiri coast, Maharashtra, India	Journal of Experimental Zoology India	2023, 26 (1), pp. 695-697, NAAS 5.25

ii) Full length Research Papers in the Proceedings of Conferences/Seminars:

Sr. No.	Author/s	Title of the paper	Conference	Year/ISBN
1.	S. A. Mohite, S. Shenoy	Case studies of women's co-operative societies in fisheries from Ratnagiri District (Konkan, Maharashtra)	Proceedings of International conference on 'Women in fisheries' conducted by the Indian Society of Fisheries Professionals, Mumbai	December, 2001 ISBN-901431-0-7 Pp. 128-134
2	A.S.Mohite and S.A.Mohite	Sustainable development of the venerid clam resources along south – west coast of Maharashtra	Proceedings of the INTERNATIONAL CONFERENCE on "Ethical Prospects: Economy, Society and Environment" University of Mumbai, 13-14 March 2015	2015, 92-99 ISBN 978-93-83046-46-1
3	S.A.Mohite, P.V.Salvi, B.V.Mahakal, and H.R.Bhatker	Novel bacteria from the marine sponges of Maharashtra coast: a perspective	Proceedings of the INTERNATIONAL CONFERENCE on "Ethical Prospects: Economy, Society and Environment" University of Mumbai, 13-14 March 2015	2015, 251 - 256 ISBN 978-93-83046-46-1

4	S.A.Mohite, P.V.Salvi, B.V.Mahakal, H.R.Bhatker and Shishirkumar	Study of marine sponges of southwest Maharashtra coast	Proceedings of the INTERNATIONAL CONFERENCE on “Ethical Prospects: Economy, Society and Environment” University of Mumbai, 13-14 March 2015	2015, 209 - 214 ISBN 978-93- 83046-46-1
5	Pakhmode P.K., and Mohite S.A.	Diversity of Bivalves at Mirya and Aare-Ware Rocky Shores of Ratnagiri, Maharashtra, India	Proceedings of National Conference on Recent Advances in Science and Technology, 17-18 Feb.2016	2016, 465 - 469 ISBN: 978- 93-83045-31- 7

i) Books: 7

1.	Mohite S.A.	Biology, Ecology and Culture of <i>Paphia malabarica</i>	LAP LAMBERT Academic Publishing AG & Co. KGDudweiler Landstr. 99, 66123 Saarbrücken, Germany	ISBN: 978-3-8383- 6128-4 (2010) Pp. 1 – 248
2.	Mohite S.A.	Study of effects of pesticides on common carp, <i>Cyprinus carpio</i> spawn	LAP LAMBERT Academic Publishing AG & Co. KGDudweiler Landstr. 99, 66123 Saarbrücken, Germany	ISBN: 978-3-8833- 5853-8 (2010) Pp. 1 – 53
3.	Suresh Kumar P. & Mohite S.A.	Biology of <i>Nemipterus japonicus</i> off Ratnagiri coast, Maharashtra, India	LAP LAMBERT Academic Publishing AG & Co. KGDudweiler Landstr. 99, 66123 Saarbrücken, Germany	ISBN: 978-3-659- 11909-5 (2012). Pp 1- 99

4	Sawant P. P. & Mohite S.A.	Biology of <i>Meretrix meretrix</i> (Linnaeus, 1758) off Ratnagiri, India	LAP LAMBERT Academic Publishing AG & Co. KG Dudweiler Landstr. 99, 66123 Saarbrücken, Germany	ISBN 978-3-659-50896-7 (2013). Pp. 129.
5	Jadhav T.D. & Mohite S.A.	Biology of <i>Megalaspis cordyla</i> off Ratnagiri, Maharashtra, India	LAP LAMBERT Academic Publishing AG & Co. KG Dudweiler Landstr. 99, 66123 Saarbrücken, Germany	ISBN 978-3-659-55048-5 (2014). Pp. 129
6	Pakhmode P.K & S.A. Mohite	Biology of <i>Lepturavcanthus savala</i> (Cuvier, 1829) off Ratnagiri coast	LAP LAMBERT Academic Publishing AG & Co. KG Dudweiler Landstr. 99, 66123 Saarbrücken, Germany	ISBN 978-3-659-91399-0 (2016). Pp. 129

v) Book Chapters:1 (List attached)

1	Pallavi K. Pakhmode and Swapnaja A. Mohite	(Book chapter) Integrated Rice-Cum-Fish Culture	Multidisciplinary Approach: Enhanced Agriculture Production in a Sustainable Way. Ed.: Shweta Sharma and Dilbag Singh	ISBN: 978-93-5891-491-7 (2023), Pp. 233
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