2017

ANNUAL REPORT & ACCOUNTS

NARA



National Aquatic Resources Research and Development Agency
Crow Island, Colombo 15
Telephone : 011 2521000, 011 2521006 Fax : 011 2521932
Web : http:// www.nara.ac.lk

MINISTRY OF FISHERIES & AQUATIC RESOURCES DEVELOPMENT

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NATIONAL AQUATIC RESOURCES RESEARCH & DEVELOPMENT AGENCY

1. CORPORATE INFORMATION

The National Aquatic Resources Research and Development Agency (NARA) is the principal national institution charged with the responsibility of carrying out and co-coordinating research development and management activities on the subject of aquatic resources in Sri Lanka. NARA was established in the year 1981 by restructuring the Research Division of the Department of Fisheries. In the restructuring process Research Division was amalgamated with the institute of Fish Technology which existed in the present premises of NARA at Crow Island, Mattakkuliya, Colombo15 to establish a fully fledged research agency, under an Act of Parliament, National Aquatic Resources Agency Act No. 54 of 1981 and amended subsequently by National Aquatic Resources Research and Development Agency Act No. 32 of 1996. The following Vision, Mission, Goals/Objectives as the highlights of the NARA functions as a statutory body under the Ministry of Fisheries and Aquatic Resources Development are as follows.

Our Vision

To be the premier institution for scientific research in conservation, management and development of aquatic resources in the region.

Our Mission

To provide innovative solutions for national development issues in the aquatic resources sector utilizing scientific and technological knowledge & resource base.

The main objectives and functions of the Agency:

- To ensure application and utilization of Scientific and Technological expertise for the implementation of national development programs.
- To promote and conduct research activities directed at identification, assessment, management and development of living and non-living aquatic resources.
- To co-ordinate and provide advisory and consultancy services on matters relating to exploitation, management and development of aquatic resources.
- To undertake collection, dissemination and publication of scientific research information on aquatic resources & related subjects.
- To provide training related to fisheries and aquatic resources fields.

Governing Board

The Governing Board consists of Eight (08) Appointed Members and Eight (08) Ex officio members in accordance with the Section 6 of the National Aquatic Resources Research & Development Agency Act No 54 of 1981 as amended by Act No 32 of 1996. The following members served as the members of the Governing Board during the year 2017 and twelve (12) Board Meetings were held during the year.

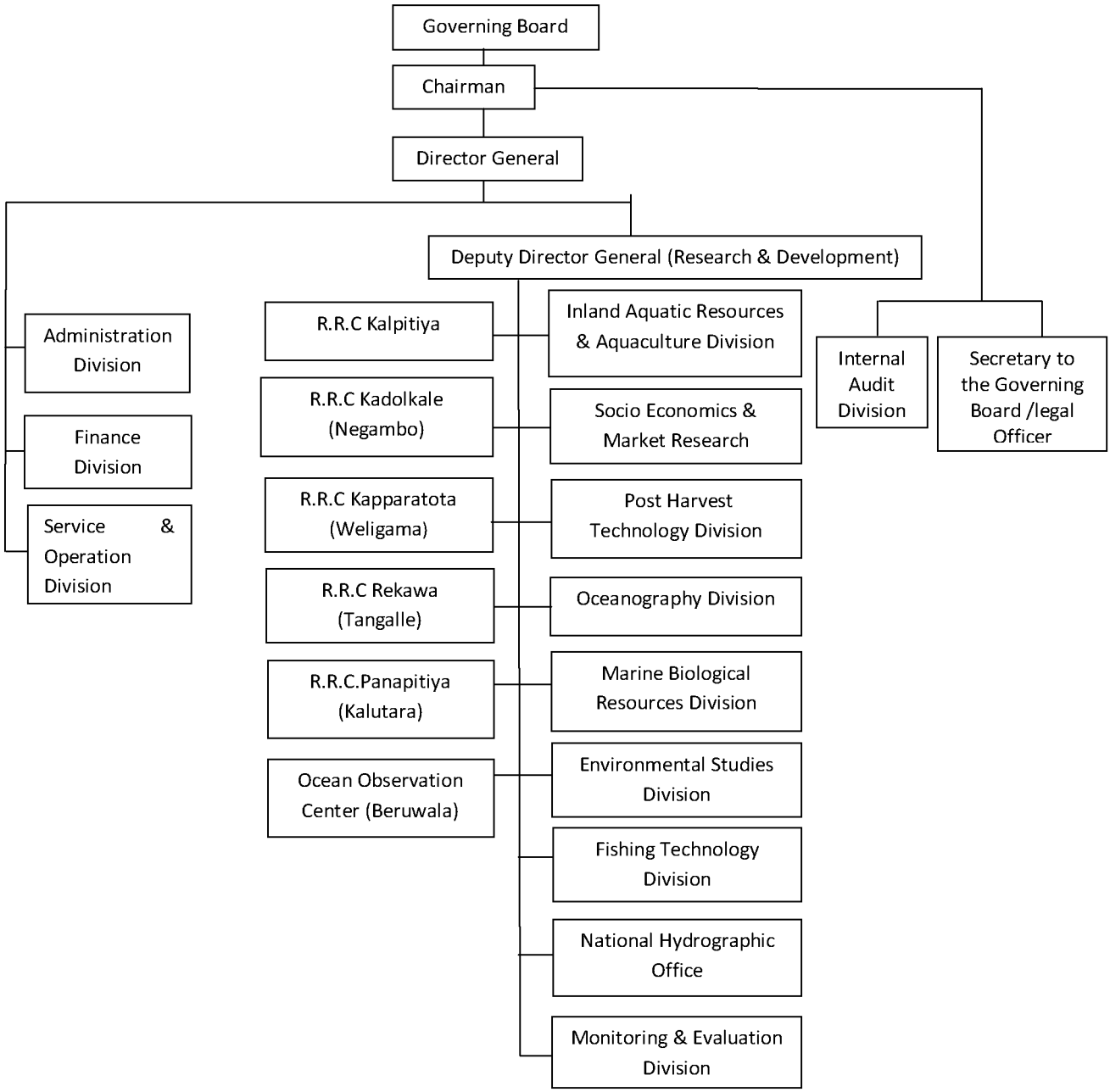
Appointed Members

1) Dr Anil Premarathne -Chairman
2) Mr. E. A. D. B. Gamini Perera -Board Member
3) Mr. Noel Palliyaguru AAL -Board Member
4) Mr. T. M. Nihal -Board Member
5) Prof.W.M.T.B. Wanninayake -Board Member
6) Mr. Sadun Malinda Thenuwara -Board Member

Ex –officio Members

1) Mr. M.M.C.P.Mohottigedara -Board Member
2) Ms. T.B. Fahmiya -Board Member
3) Rear Admiral S. Jayakody -Board Member
4) Mr. P.M.P.Udayakantha -Board Member
5) Mr. M.C.L. Fernando -Board Member
6) Mr. A. Abdul Majeed -Board Member
7) Mr. B.C.W.Iddamalgoda -Board Member

Organizational Structure



Organization

Dr.Anil Premarathne functioned as the Chairman and Mr.B.C.W.Iddamalgoda functioned as the Director General during the year under review. In order to perform the mandated functions of the Agency the organization had been designed to constitute nine Research and Technical/Services Divisions, Environmental Studies, Fishing Technology, Hydrographic Office, Inland Aquatic Resources & Aquaculture, Monitoring & Evaluation, Marine Biological Resources, National Institute of Oceanography & Marine Sciences, Socio-Economic and Market Research, Institute of Post Harvest Technology divisions. Supported divisions were, Administration, Services & Operations and Finance Divisions.

Following officials officiated as Heads of Divisions during the year 2015.

Research Divisions

Mr. S. A. M. Azmy 01.01.2017 - 01.08.2017 Ms.K.A.W.S.Weerasekara 02.08.2017 - 31.12.2017	Environmental Studies Division
Mr. N. B. P. Punyadeva	Fishing Technology Division
Mr. A.N.D.Perera	Hydrographic Division
Dr. V. Pahalawattaarachchi	Inland Aquatic Resources & Aquaculture Division
Dr.S.S.K.Haputhantri	Marine Biological Resources Division
Dr.K.Arulananthan	National Institute of Oceanography & Marine Sciences
Dr.G.J.Ganegamaarachchi	Institute of Post Harvest Technology
Mr. K. H. M. L.Amaralal	Socio Economics & Market Research Division
Mr. A. B. A .K. Gunaratne	Monitoring & Evaluation Division

Support Services Divisions

Director General	Administration Division
Mr.M.D.Senarathne(Actg.) (01/01/2017 – 16/04/2017) Mr.N.S.Hewagama 17.04.2017 -31.12.2017	Finance Division
Mr.S.K.S.Liyanaarachchi	Services & Operation Division
Ms.K.G.L.Iranganie(Actg.) 01.01.2017 - 16.04.2017 M.D.Senarathne 17.04.2017 -31.12.2017	Internal Audit Division

2. RESEARCH HIGHLIGHTS-2017

Dr. H.M.P. KIthsiri, Deputy Director General Research and Development
Mr. A.B.A.K.Gunaratne, Director Monitoring and Evaluation

Inland Aquatic Resources and Aquaculture

The breeding technologies for economically important high value exotic ornamental fish species Sahyadriadenisonii and Balantiocheilos melanopterus has been provided to farmers and initiated community based high value ornamental fish culture project. Simultaneously, technology has been developed for captive breeding of endemic ornamental species, Rasboranigrom arginata through environment manipulation. Puntius thimbiri, Rasbora nigromarginata, Laubuca insularis and Puntius kelumi are the species which were newly introduced to the ornamental fish industry.

Indoor (laboratory) culture technology was developed successfully for *Spirulina,* in Zarrock media, highly nutritious blue green algae and two other most important micro algae *Nannochloropsis* and *Chetocerous*, mostly use in aquaculture were successfully cultured incorporating commercial probiotics. Newly introduced round type cages at Dondra can be used to keep seeds of the *Kapaphycus alverezii* during rough weather with maximum SGR 7% in 14 days . The capacity of 01 cage was 50-100kg depending on the sea conditions. It could be able to keep 500-1000kg of seeds at the nursery for one time. In *Ulva lactuaca* culture experiments, highest swarmer density was obtained when the thallus was exposed to 2˚C temperature shock for 10 minutes. The best media composition for *Anubias barteri var. Nana, an*economically high value species was Murashige and Skoog media with 4mg/L Benzyle adenine purine growth hormone (BAP).Newly designed Spat collectors using PVC and plastic casine were found suitable for spat collection due to the number of spats attached and easy for spat detachment.

Nutritionally balanced economical feed formula for Asian Seabass in plastic net cages (2mx2m) were examined for 3 months in an earthen pond from 30 g up to 200g. Addition of shrimp meal combining with CM fish meal® in the sea bass diets showed the better performances. The production cost of the experimental sea bass feed was closer to Rs. 170.00. Highest average weight gain of Crabs was achieved using formulated feed (protein 40%)at a price of Rs.165/Kg feed. Effects of Chitosan as an immune stemulant in juvenile tiger shrimp was examined in a re-circulated tank system for 46 days. Addition of 2% Chitosan showed the better survival and growth rate of juvenile tiger shrimp. By the WSSV challenge test, the shrimp fed 2% Chitosan in-cooperated diet showed better survival rate in an extreme condition than shrimp fed control and 4% Chitosan in-cooperated diets. An experiment for juvenile seacucumberfeeds to replace high value fish meals by brewers' yeast was conducted for 55 day in a re-circulatory tank system and survival rate (≥ 75%); growth rate was improved by adding brewers' yeast to the diet. The replacement level of fish meal by brewers' yeast was closer to 15 % in juvenile sea cucumber diets. Four fish feeds were produced for ornamental fish at Panapitiya station and provided to the farmers.

The studies completed on horizontal transmission of WSSV virus through wild carriers recommended that presently use crab meat and Mole crabs are not suitable as brood stock feed inhatcheries, as higher percentage of the creatures are infected with WSSV. Bio security measures should be applied to avoid contamination of Sand white ghost crab, Mud crabs, Mangrove crabs with the grow out ponds. Ornamental fish disease surveillance programme revealed that prevailing diseases in high density were Gill/skin flukes and *Trichodina* infections in Gampaha, Kalutara& Galle districts. Severalty of disease is highest in July to August and guppy, sward tail, platy, and fighter fish were the most affected.

With considering the environmental parameters including water quality (Microbiological, Physio- Chemical and Heavy Metal), water depth, existing oyster beds, access to the road and canal outlets (from urban and aquaculture ponds), site suitability analysis was performed to zonation of oyster culturing area, Brood stock growing area and Depuration area in the Puttalam Lagoon. The analysis showed that totally 9.7 sq km is most suitable area for brood stock growing while 17.4 and 12.5 sq km for Oyster farming/culturing and depuration respectively.

Marine Biological Resources

With respect to the updated large pelagic fishery database (PELAGOS) and small pelagic database, among the oceanic tuna species landed, the catch is dominated by skipjack tuna (54%) followed by Yellowfin (40%) and Bigeye tuna (6%) respectively. A fishery dependent survey was conducted to assess the status of key export oriented fishery resources in the Northern waters. *Bohadschiamarmorata* ("kirinoolattaya") is the key sea cucumber species recorded in Mullaitivu. Fishery and biological aspects of manta ray were also studied in the west coast of Sri Lanka. The nursery grounds of manta rays are likely be located close to the fishing grounds. A major change has taken place recently in the beach seine fishing industry due to the introduction of a winch to operate the beach seine net. Accordingly, the fishing area is being widened and the efficiency of the gear is also being increased. Therefore, few recommendations were made to implement in the beach sine fishery with the aim of minimizing the environment impacts and user conflicts among the resource users.The biological and molecular studies done for the 3 neritic tuna species *Auxis thazard*, *Auxis rochei* and *Euthynnus affinis* show that the stocks of the different regions could be considered as belonging to a single stock when formulating management plans for these species. All 3 species showed healthy growth patterns and non-selective feeding habits. Some biological and fisheries aspects of selected reef fish (edible) were studied with the aim of introducing new management measures for sustainable utilization of respective resources. Among the three fisheries districts studied in west coast, Chilaw fishery district recorded the highest reef fish species diversity; 12 species from the family Serranidae and 12 species from family Lutjanidae whereas Negombo fishery district recorded the lowest species diversity; 8 species from the family Serranidae and 9 species from family Lutjanidae. The study revealed that breeding season of *Cephalopholis sonnerati, Epinephelus longispinis and Lutjanus fulviflamma* varied from December to February, August to October and February to April & August to October respectively.Management recommendations were proposed in terms of introducing closed season(s) during the spawning season(s) and minimum catching size etc. Octopus is currently landed as a by-catch in small quantities for fishing gears that operate targeting other fish and a new fishing trap was tested during the study. The trap used was recommended as an effective and selective fishing gear for catching octopus.

Turtles study concluded that gillnet fishery has a low sea turtle interaction compared to longline but relatively higher mortalities are recorded for gillnets than long line. The spatial and temporal distribution of cetaceans around Mirissa, 11 species of cetaceans were recorded and blue whales were recorded in every season of the year with a higher abundance. A reef survey was conducted at Hikkaduwa and Pigeon Island National parks and Bar reef marine sanctuary with the aim of monitoring the bio-physical & socio-economic impacts due to coral bleaching and anthropogenic activities. Forty two coral species belonging to 20 genera and 12 families and eighty-one species of reef fish belonging to 45 genera and 23 families were recorded from three sites.

Post Harvest Technology

Quality depreciation of fish in multi-day boats (MDT) was assessed for skipjack tuna and yellow fin tuna unloaded at the selected fishery harbours.Simultaneously, microbiological and biochemical quality of Yellow fin tuna harvested targeting export market were assessed. The average post-harvest quality losses (wt/wt) of skipjack tuna was 28±13.8% at Beruwala, 17.1±14.4% at Negombo, 32.2±15.0 atMirrissa, 30.3±6.3% atDondra, and 39.3±9.9% at Puranawella. Quality loss of Yellow fin tuna was 9.7±12.7% at Trincomalee, 32% at Kalpitiya and 37% at Dickowita. Nearly all ice samples were heavily contaminated with faecal coliforms. All the harbour basin water samples were heavily contaminated with *E. coli*. Twenty % (2/10) of harbour water of Dikkowita fishery harbour was detected with *Salmonella* spp. out of two samples from Kalpitiya fishery harbour one sample was detected with *Salmonella.* Bilge water of Beruwala and Negombo fishery harbours contained *Salmonella* 30 and 12%, respectively. 20 % of the ice samples obtained from factories which supply ice to Negombo and Dikkowita fishery harbours contained *Salmonella*. Therefore, contamination of fish is unavoidable due to use of this contaminated ice, water in handling of fish in boats and harbours. From the 30 Yellowfin tuna fish surface samples Faecal coliform counts were detected in the range of 0.02 MPN/cm^2 to 20.33 MPN/cm^2 and *E. coli* counts were ranged from 0.02 MPN/cm^2 to 20.33 MPN/cm^2. One sample was detected with *Salmonella* spp. Histamine content of ten samples of Yellowfin tuna landed at Dikkowita fishery harbour were detected in the range of of 13 - 20 ppm.

Microbiological safety of edible Oysters and clams were collected from harvesting areas (Gangewadiya, Kandakuliya Anaiwasala and Janasavipura), and analyzed for microbiological parameters bacteria namely total coliforms, faecalcolifoms, *E.coli*, *Faecal streptococci*, *Vibrio cholerae*, *Vibrio parahaemolyticus* and *Salmonella* spp. Microbiological quality of lagoon water is suitable for natural relaying of bivalves with the exception of a very few instances. Oysters, clams and water (n=10) were collected from harvesting areas and tested for following biotoxins using ELISA method. Biotoxins were not detected in oysters, clams and water samples.Protocols for depuration of oysters and clams were readjusted. Efficacy of depuration plant installed in Kalpitiya RRC for cleaning of bivalves was monitored.Microbiological quality data of bivalves and water from harvesting areas were provided to the competent authority in order to facilitate bivalve exports and domestic sales.

Low-slated dried fish product and the shelf life and nutritional value determination experiment reveals that using brine of 10% salt strength and soaking for 30 minutes, water phase salt value of dried fish can be brought to value of more than 20% which is safe to store at room temperature. The protein content of low-salted dried fish is comparatively higher than the dried fish prepared using the traditional method. To avoid spoilage due to microbial activities it is recommended to dry low-salted dried fish inside a solar dryer under hygienic conditions. Low-salted dried fish which are polythene packed and kept under environmental conditions can be stored for more than three months time maintaining the safe to consume status. To prolong the shelf life it is recommended to vacuum pack the low-salted dried fish. Low-salted method is much more suitable for large fishes cut in to slices than for small fishes.

A low cost technology to produce chitosan with higher Degree of Deacetylationwas investigated. The values for DD, moisture content, ash content, water binding capacity and fat binding capacity of chitosan produced by this method were 87%; 5.92%; 30.34%; 952.94; and 645.81%, respectively.

Oceanography & marine Sciences

Quality of the potential fishing ground forecasting bulletin is improved by incorporating the prediction of accurate fishing depth. The Yellowfin tuna is thermocline associated and it is very important to know the thermocline depth as it seasonally change from about 50 m to 150 m in the Indian Ocean. Therefore, to enhance the catch rates, the information on the fishing depth in space and time is important for setting fishing lines. Fisheries official of Ministry of Fisheries Aquatic Resources Development and Department of Fisheries were trained on the usage of Fisheries Bulletin. Fishers from the major fisheries harbors were also trained on the usage of fisheries bulletin.

Modera sea level station is shifted to Colombo harbor and made functional.Trincomalee sea level station is made functional. A collaborative project is developed between First Institute of Oceanography (FIO), China and NARA.A new station is established at Mirrissa with the financial assistance of FIO, China. Prediction of ocean wave and wind on a regional scale is completed and validation for forecasting commenced.

Highest primary productivity in terms of phytoplankton was reported in Mirissa. Harmful algal blooms are not reported during the study period at three study sites (off Colombo, Beruwala and Mirissa). Total of 10 toxic sps. are reported during the study belongs to genera *Alexandrium*sp., *Gymnodinium*sp., *Protoperidinium*sp.,*Prorocentrum*sp.,*Dinophysis*sp.,*Noctiluca*sp.,*Gymnodinium*sp. However, as their abundances are low, there is no possibility for formation of dinoflagellates or toxic blooms.Diatom species of*Chaetoceros*sp. (35%),*Trichodesmium*sp. (85%) and *Nitzschia*sp. (50 %)are dominatedin Colombo, Beruwala and Mirissa respectively and indicate the possibility of blooms of these diatom species at particular sites when environmental conditions are favorable.

The study morphologically identified different categories of plastics and quantified with an emphasis on micro-plastics in coastal sand and surface waters in Colombo, Beruwala and Hikkaduwa. The vast majority of plastic particles found at a significant degree are micro-plastics in the range of 250 µm–5 mm. The second and third most abundant categories are Meso and Macro plastics.Colombo is the most polluted site with micro-plastics where the highest abundance was reported from Wellawatte whilst the least was recorded from Uswetakeiyawa. Beruwala is more polluted with plastics compared to Hikkaduwa.

Fishing Technology

Submerged Fish Enhancing Devices were installed in Sinnapaduwa Sea area in Puttalam District. Around the subsurface FEDs *Lutjanusfulviflamma,Ciganusspp, Plectorhinchusspp,* Rainbow runners, Leather jacket, Squids, mackerel scads and other small fish species were recorded. Furthermore observations need to be carried out to determine the performance of FEDs and more submerged structure need to be deployed to enhance the fish resources.

Habitat enhancement for "Big Fin Reef Squid" spawners (*Sepioteuthislessoniana*) at their own breeding ground was carried out in Sinnapaduwa fishing area with community participation. For enhancing marine habitat and support to the spawning process of the big fin reef squids "*Sepioteuthislessoniana"*, three types of structures were constructed and deployed at selected area in Sinnapaduwa with participation of fisherman. During the project period artificial structures were deployed at three different depths starting from 10m, 15m and 20m under the calm sea condition. 12 units of each structure were deployed before monsoon period. Data of squid's egg attachment were collected and number and type of attached squid's eggs were recorded. Aggregated fish species around the structures were monitored. *Loligo*sp, *Sepioteuthislessoniana*(Squids) and *Sepia* sp (Cuttlefish) eggs were observed. *Sepioteuthislessoniana*eggs were recorded in 86.8 % percentage while other two types recorded in 13.2 % .

Out of the three types of structures, conical shaped structure is preferred by squids as a place of attachment with percentage of 95.55% to the cylindrical one (Plastic barrel structure)which is only 4.45 %. No squids attachment was recorded in string shaped structure (a bunch of coir rope). Therefore conical shaped structures are recommended to deploy further to enhance the squids stock in natural environment.

Environmental Studies

In order to formulate environmental management plan, environmental profiles of the lagoons of Negombo, Kokilai, Puttalamwere submitted to the Ministry of Fisheries and Aquatic Resources Development with recommendations

BentharaRiver indicated low productivity levels of the Dedduwa estuary and some of the measured water quality levels indicated low BOD (Biochemical oxygen demand (3.22±1.32mg/L), moderate total suspended solids (14.0±7.66mg/L)) and high oil & grease (3.55±2.14mg/L) contents. Results of macro invertebrate study revealed that, class Gastropod represented the 71.35% from the total benthic composition.

Identify the causes for the Chronic Kidney Disease (CKDu) revealed that the average concentration of Cd of kidney tissues in two selected feral fish species sampled from the Padaviya Reservoir (Tilapia & Pena walaya) were above the standard limits (>0.05 mg/kg) (Wallaya (0.31 ± 0.21), Tilapia (0.11 ± 0.05) mg/kg. However, Cd in fish flesh were not detected in Walaya fish flesh samples and 0.43 mg/kg Cd concentration were detected in only one Tilapia fish flesh sample , which was above the standard limits (>0.05 mg/kg) defined by European Union, regulation number 1881/2006 of 19 December 2006 .It also revealed that, weedicide glyphosate and heavy metals (lead (Pb), cadmium (Cd), mercury (Hg) and arsenic (As))in all water samples were less than the detection limits.

In Norochcholai coal power plant indicated that, water temperature at the discharge point of the power plant were greater than inlet temperature in all the times. The average difference between inlet and outlet is 5 °C and the highest difference was recorded in the study period was 7.4 °C. In addition to that, high chromium(Cr) levels (> 2.5 mg/kg) were detected in selected sediment samples. Coal fallings during the loading and unloading process was alsoobserved during the study period and it could be harmful to marine organisms in a long run.

Results of the emergency study project identified that,majority of the fish killincidents of the water bodies of the country were occurred due to poor aquatic environmental health conditions owing to low dissolved oxygen levels and overcrowding of fish specially Thilapia fish species. Total of seven fish kill incidents were investigated at Nandikadal Lagoon, RagamaKajugahaKubura Wawa, Anuradapura Kala Wewa, PolonnaruwaKaudullaWewa, HambanthotaBandagiriyaWewa, TrincomaleeMahadiwulwewa, and KottawaMahabowewaduring the period.

Socio-Economic & Marketing Research

Main findings of the project on institutional barriers for the development of aquaculture industry were delays in land acquisition, environmental clearance and local government approvals. According to the findings of the project on economic impact of winch introduction to the beach seine fishery were the comparative performance is higher in mechanized beach seines compared to that of traditional beach

seines but has to be concerned on environmental issues prior legalized the mechanized beach seine fishery. The findings of the project on cost of production have proved that multi-day boat group 33-40 ft length were enjoyed highest annual profit while the lowest recorded by the boat group 28-32 ft length.

National Hydrographic Surveys

. The total area surveyed in Kankasanthurai was 450 sq.km for the purpose of compilation of Nautical Chart, Approaches to Kankasanthurai in the scale of 1:75,000. Also 410 sq.km and 6425 sq.km areas were covered during the year 2017 corresponds to compilation of Coastal Charts, Colombo to Weligama in the scale of 1:150,000 and Trincomalee to Point Kudremalai in the scale of 1: 300,000.

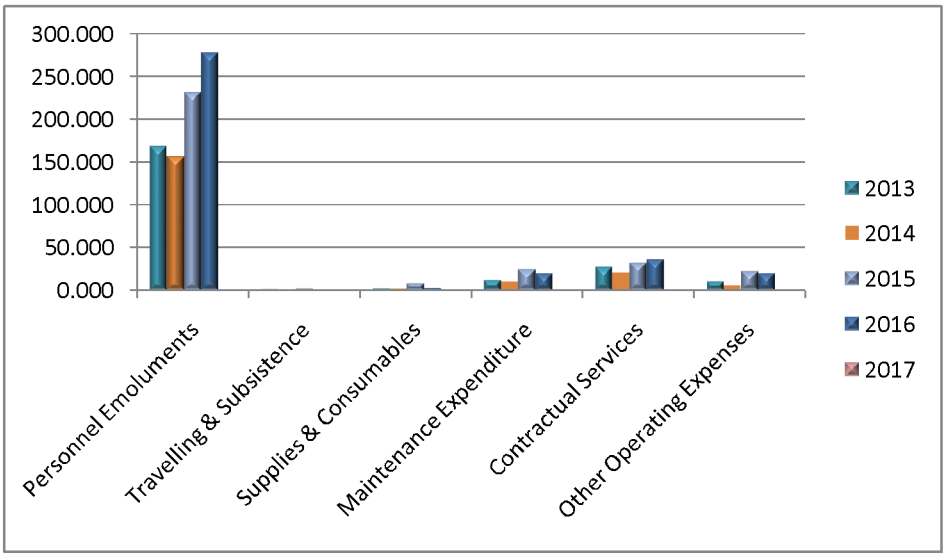
3. FINANCIAL HIGHLIGHTS

Financial Highlights at a Glance

Recurrent Expenditure

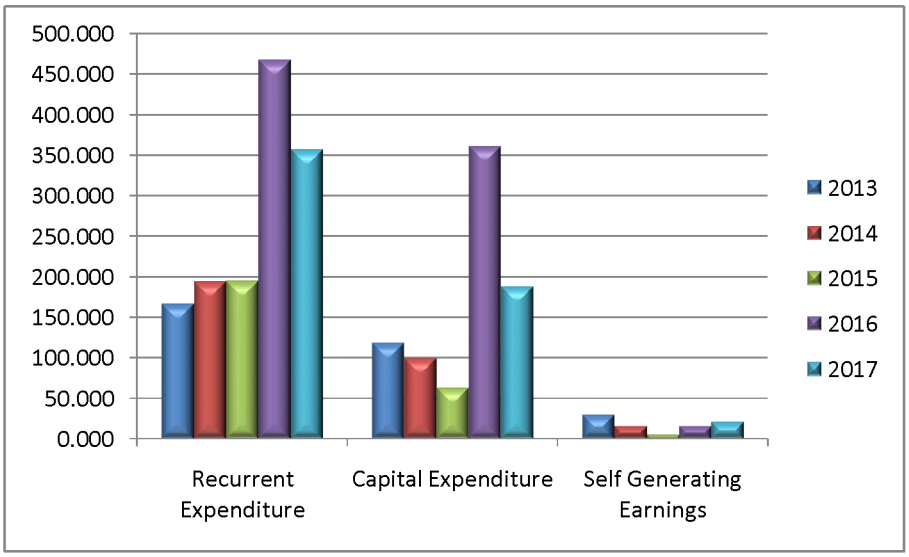
Rs. Million

Description	2013	2014	2015	2016	2017
Personnel Emoluments	142.376	168.164	156.053	231.524	278.110
Travelling & Subsistence	1.602	1.250	0.248	2.300	0.298
Supplies & Consumables	4.353	2.074	1.576	8.525	2.366
Maintenance Expenditure	14.064	11.879	9.871	24.850	20.133
Contractual Services	22.443	27.433	20.874	32.250	36.211
Other Operating Expenses	13.950	10.814	6.016	22.450	20.091
Total	**198.788**	**221.613**	**194.638**	**321.899**	**357.209**



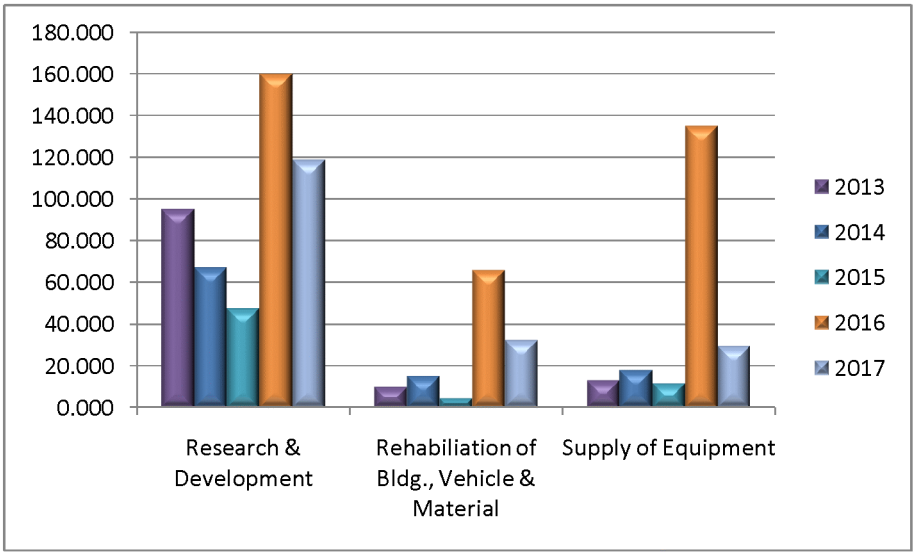
Estimated Budget
(Rs.) Million

Description	2013	2014	2015	2016	2017
Recurrent Expenditure	166.894	194.260	194.638	467.598	357.209
Capital Expenditure	118.272	100.000	63.424	361.000	188.000
Self Generating Earnings	30.000	16.060	5.370	16.000	20.810
Total	**315.166**	**310.320**	**263.432**	**844.598**	**566.019**



Capital Expenditure
(Rs) Million

Description	2013	2014	2015	2016	2017
Research & Development	95.000	67.000	47.464	160.000	118.829
Rehabiliation of Bldg., Vehicle & Material	10.000	15.000	4.358	66.000	32.456
Supply of Equipment	13.000	18.000	11.602	135.000	29.530
Total	**118.000**	**100.000**	**63.424**	**361.000**	**180.815**



4. HUMAN RESOURCES INFORMATION

Recruitments 2017

No	Name	Designation	Per/con	Appointed Date
01	Mr.P.M.Jayasinghe	Research Assistant	Permanent	03.01.2017
02	Ms.W.A.D.Thilini	Research Assistant	Permanent	03.01.2017
03	Ms.G.L.A.Subashini	Research Assistant	Permanent	03.01.2017
04	Mr.J.A.Darshana	Research Assistant	Permanent	03.01.2017
05	Mr.W.D.P.D.Wijesinghe	Research Assistant	Permanent	03.01.2017
06	Mr.G.G.Thushara	Skipper	Contract	03.01.2017
07	Mr.B.M.M.Senarathne	Technical Officer (Mechanical)	Permanent	09.01.2017
08	Mr.K.Balamannage	Landscaping Officer	Permanent	10.01.2017
09	Mr.K.A.P.Danushka	Field Research Assistant	Permanent	03.01.2017
10	Mr.T.K.Isuru Thiwanka	Development Officer	Permanent	06.03.2017
11	Mr.N.S.Hewagama	Director/ Finance	Permanent	17.04.2017
12	Mr.K.Guruge	Coxswain	Contract	15.05.2017
13	Mr.M.N.H.C.W.Mihiranga	Technical Officer (Mechanical)	Permanent	08.08.2017
14	Mr.W.M.S.Sadaruwan	Technical Officer (Civil)	Permanent	16.08.2017
15	Mr.R.H.M.Sameen	Management Assistant(Transport)	Permanent	04.09.2017
16	Ms.K.A.M.Udayangani	Secretary to the Governing Board & Legal Officer	Permanent	25.09.2017
17	Mr.E.A.N.S.Madushanka	Helper	Permanent	01.11.2017
18	Mr.R.K.Supun Piyadarshana	Helper	Permanent	01.11.2017
19	Mr.W.A.A.Chandana	Helper	Permanent	01.11.2017
20	Mr.S.K.A.Ruwan Jayalath	Helper	Permanent	01.11.2017

Departures

No	Name	Designation	Per/con	Departure Date	Remarks
01	Mr.T.H.M.D.Peris	Book Binder	Permanent	28.01.2017	Pension
02	Ms.K.A.A.N.Jayarathne	Secretary to the Governing Board and Legal Officer	Permanent	20.01.2017	Resigned
03	Ms.J.M.Chandrika	Research Assistant	Permanent	19.01.2017	Pension
04	Ms.B.I.M.Anuradha	Development Officer(Project)	Permanent	17.02.2017	Resigned
05	Mr.D.M.T.U.Bandara	Scientist	Permanent	28.03.2017	Resigned
06	Mr.U.G.Janaka Kumara	Driver	Permanent	02.04.2017	Pension
07	Mr.L.Ginige	Diver	Permanent	02.04.2017	Pension
08	Ms.V.J.D.Weerasekara	Management Assistant	Permanent	11.05.2017	Pension
09	Ms.W.D.P.D.Wijesinghe	Research Assistant	Permanent	15.05.2017	Resigned
10	Mr.G.G.Nishantha	Helper	Permanent	01.05.2017	Resigned
11	Mr.B.M.M.Senarathne	Technical Officer(Mechanical)	Permanent	14.03.2017	Resigned
12	Mr.J.A.Darshana	Research Assistant	Permanent	01.06.2017	Resigned

13	Ms.R.M.S.Darmasiri	Scientist	Permanent	24.06.2017	Resigned
14	Mr.S.A.M.Azmy	Senior Scientist	Permanent	01.08.2017	Pension
15	Mr.T.D.W.Kasthuriarachchi	RA	Permanent	04.09.2017	Resigned
16	Mr.N.B.Sooriyaarachchi	Scientist	Permanent	28.09.2017	Terminate
17	Mr.A.N.Gajaweera	Helper	Permanent	16.10.2017	Resigned
18	Ms.D.G.I.S.Rupamala	DO	Permanent	04.10.2017	Resigned
19	Mr.P.M.Jayasinghe	RA	Permanent	04.11.2017	Resigned
20	Ms.J.L.T.M.Silva	RA	Permanent	06.11.2017	Resigned
21	Mr.K.A.P.Danushka	FRA	Permanent	26.10.2017	Resigned
22	Mr.P.G.Munasinghe	LA	Permanent	28.11.2017	Pension
23	Mr.B.K.K.K.Jinadasa	Senior Scientist	Permanent	14.12.2017	Resigned
24	Ms.A.A.D.Gayathri Upeksha	RA	Permanent	21.12.2017	Vacation Post
25	L.G.Hasini	Helper	Permanent	20.11.2017	Vacation Post

Unfilled vacancies

Srl No.	Designation	Salary Code	Service Level	Approved Cadre	Vacant
1	Director (Admin/HR)	HM1-3	Senior Level	1	1
2	Principal Scientist	HM1-3	Senior Level	11	1
3	Senior Scientist	AR-2	Tertiary Level	21	2
4	Senior Hydrographic surveyor	AR-2	Tertiary Level	2	1
5	Scientist	AR-1	Tertiary Level	80	31
6	Sociologist	AR-1	Tertiary Level	1	1
7	Economist	AR-1	Tertiary Level	1	1
8	Hydrographic Surveyor	AR-1	Tertiary Level	8	2
9	Senior Cartographer	MM 1-2	Tertiary Level	1	1
10	Senior System Analyst /Programmer	MM 1-2	Tertiary Level	1	1
11	Data Analyst	MM 1-2	Tertiary Level	1	1
12	Asst. Director (Service & Operation)	MM 1-2	Tertiary Level	1	1
13	Asst .Director (Admin)	MM 1-2	Tertiary Level	1	1
14	Asst. Director (Information Technology)	MM 1-2	Tertiary Level	1	1
15	Senior Extension Officer	MM 1-2	Tertiary Level	1	1
16	Assistant Director (Vessel Operation & Maintenance)	MM 1-2	Tertiary Level	1	1
17	Administration Officer (HR)	JM1-2	Secondary Level	1	1
18	Cartographer Data Analyst (Nautical)	JM1-2	Secondary Level	1	1
19	Cartographer Data Analyst (GIS)	JM1-2	Secondary Level	1	1
20	System Analyst /Programmer	JM1-2	Secondary Level	1	1
21	Land Surveyor	JM1-2	Secondary Level	1	1
22	Cartographer	JM1-2	Secondary Level	2	1

23	Diving Officer	JM1-2	Secondary Level	1	1
24	Translator	MA 4	Secondary Level	3	3
25	Development Officer (Project)	MA 3	Secondary Level	20	4
26	Assistant Network Administrator	MA 2-2	Secondary Level	1	1
27	Field Research Assistant	MA 2-2	Secondary Level	13	4
28	Research Assistant	MA 2-2	Secondary Level	70	28
29	Cartographic Draughtsman	MA 2-2	Secondary Level	2	2
30	Head Driver/Marine	MA 2-2	Secondary Level	1	1
31	Multi Media Designer	MA 2-2	Secondary Level	1	1
32	Draughtsman	MA 2-2	Secondary Level	2	1
33	Diver	MA 2-2	Secondary Level	3	3
34	Diver Assistant	MA 2-2	Secondary Level	1	1
35	Technical Assistant (Electrical)	MA 2-2	Secondary Level	1	1
36	Management Asst.. (Library)	MA 2-2	Secondary Level	2	2
37	Ocean Observation Technician	MA 2-2	Secondary Level	1	1
38	Assistant Skipper	MA 2-2	Secondary Level	1	1
39	Geological information System Technician	MA 2-2	Secondary Level	1	1
40	Radio Officer	MA 2-2	Secondary Level	1	1
41	Management Assistant	MA1-2	Secondary Level	38	4
42	Hydrographic Assistant	MA1-2	Secondary Level	1	1
43	Boatswain	MA1-2	Secondary Level	1	1
44	Book-Binder	PL-3	Primary Level	1	1
45	Plumber	PL-3	Primary Level	1	1
46	Carpenter	PL-3	Primary Level	2	1
47	Mason	PL-3	Primary Level	2	2
48	Motor Mechanic	PL-3	Primary Level	2	1
49	Driver	PL-3	Primary Level	27	3
50	Deck Hand	PL-3	Primary Level	2	1
51	Marine Mechanic	PL-3.	Primary Level	1	1
52	Video Editor	PL-3	Primary Level	1	1
53	Lab Attendant	PL-2	Primary Level	12	1
54	Caretaker/Cook	PL-2	Primary Level	4	2

55	Helper	PL-1	Primary Level	87	8
56	Survey Helper	PL-1	Primary Level	6	1

Promotions

2017 Grade Promotion

Name	Recruitment date	Promotion	Promotion date
E.I.Wasantha	2006.12.01 PL-1 iii	Grade Promotion PL – 1 –ii	2015.08.01

2017 Promotion

Name	Former post	New Post	Promotion date
Mr. C.S.Peiris	Administrative officer (Human Resource)	Assistant Director (Human Resource)	15.11.2017
Ms.Y.M.R.N.Kumari	Hydrographic Survey	Senior Hydrographic Survey	15.11.2015

Local Trainings

	Name	Date	Course	Venue	Amount
1	Mr.A.M.J.Kostha Account Clerk	31.01.2017	Excel Usage	PRAG Institute	Rs.7500.00
2	Ms.K.G.I.Irangani Internal Audit officer	14.02.2017	Disciplinary Work	PRAG Institute	Rs.6000.00
3	Ms.T.G.I.S.Rupamala Development Officer (Project)	14.02.2017	Disciplinary Work	PRAG Institute	Rs.6000.00
4	Ms.M.B.I.Anuradha Development Officer (Project)	14.02.2017	Disciplinary Work	PRAG Institute	Rs.6000.00
5	Ms.Manori Rupasinghe Development Officer (Project)	09.02.2017	Diploma in Library and Science Science	Sri Lanka Library Association	Rs.16,000.00
6	Ms.Manoja Senevirathne Managmnet Assistant	08.03.2017	Training Seminar For Laboratory Technical Officers	Food Science and Technology Institute	Rs.6000.00
7	Ms.Geeshani Gunasekara Development Officer (Project)	08.03.2017	Training Seminar For Laboratory Technical Officers	Food Science and Technology Institute	Rs.6000.00
8	Mr.S.K.Abeyrathne Research Assistant	08.03.2017	Training Seminar For Laboratory Technical Officers	Food Science and Technology Institute	Rs.6000.00
9	Ms.K.S.Hettiarachchi Research Assistant	08.03.2017	Training Seminar For Laboratory Technical Officers	Food Science and Technology Institute	Rs.6000.00

10	Mr.G.P.Roshan Research Assistant	08.03.2017	Training Seminar For Laboratory Technical Officers	Food Science and Technology Institute	Rs.6000.00
11	Ms.G.S.Chathurika Research Assistant	08.03.2017	Training Seminar For Laboratory Technical Officers	Food Science and Technology Institute	Rs.6000.00
12	Ms.Subashi Gallage Research Assistant	08.03.2017	Training Seminar For Laboratory Technical Officers	Food Science and Technology Institute	Rs.6000.00
13	Ms.G.D.P.Niroshani Research Officer	31.01.2017	Database Management Course	Lalith athulath Mudali Vocational Training Centre	Rs.16,000.00
14	Ms.V.K.G.Jayasena Administrative Officer	27.03.2017- 28.03.2017	The provisions of the Establishments Code and the Procedural Rules	Skill Development Fund Limited	Rs.8500.00
15	Ms.Y.T.Wijesekara Development Officer (Project)	27.03.2017- 28.03.2017	The provisions of the Establishments Code and the Procedural Rules	Skill Development Fund Limited	Rs.8500.00
16	Ms.W.A.K.R.Mallika Management Assistant	27.03.2017- 28.03.2017	The provisions of the Establishments Code and the Procedural Rules	Skill Development Fund Limited	Rs.8500.00
17	Ms.I.J.J.Fernando Management Assistant	27.03.2017- 28.03.2017	The provisions of the Establishments Code and the Procedural Rules	Skill Development Fund Limited	Rs.8500.00
18	Ms.A.S.Wijesinghe Development Officer (Project)	20.03.2017- 21.03.2017	The duties and responsibilities of the holiday clerks	Skill Development Fund Limited	Rs.8500.00
19	Ms.A.Nisansala Perera Management Assistant	20.03.2017- 21.03.2017	The duties and responsibilities of the holiday clerks	Skill Development Fund Limited	Rs.8500.00
20	Ms.S.R.C.N.K. Narangoda Scientist	31,24.03.2017 & 28,21.04.2017 & 19,12,05.05.2017	Course on Geographical Information System	University Of Colombo	Rs.25,000.00
21	Ms.M.D.S.R. Maddumage Scientist		Course on Geographical Information System	University Of Colombo	Rs.25,000.00

22	Ms.Kalani Priyanwadha Research Assistant	30.03.2017	Uncertainty Estimation in Measurement Science	Director Department of Measurement Units Standards & Services	Rs.9500.00
23	Ms.Niroshani Research Assistant	30.03.2017	Uncertainty Estimation in Measurement Science	Director Department of Measurement Units Standards & Services	Rs.9500.00
24	Mr.C.S.Peiris Administrative officer (HR)	04.05.2017	The "Top HR Trends" lecture	Skill Development Fund Limited	Free of Charge
25	Ms.Manori Rupasinghe Development Officer (Project)	08.05.2017	Information workshop for Governmental Librarians on the Internet	University Of Colombo	Rs.1500.00
26	Ms.Menaka Karunarathne Helper	08.05.2017	Information workshop for Governmental Librarians on the Internet	University Of Colombo	Rs.1500.00
27	Mr.H.D.L.Madushanka Helper	25.05.2017 To every Thursday 10 days	Advanced Certificate Course on Storing	Construction Equipment Training Centre	Rs.21000.00
28	Dr.W.N.Wickaramaarachchi Senior Scientist	19,15.06.2017	Workshop on Procurement Process	Ministry of Fisheries and Aquatic Resources Development	Spent Amount for All Participants Rs.139,044.23
29	Ms.G.W.N.Pavithra Assistant Director (Finance)	19,15.06.2017	Workshop on Procurement Process	Ministry of Fisheries and Aquatic Resources Development	
30	Ms.K.G.L.Iranagani Internal Audit officer	19,15.06.2017	Workshop on Procurement Process	Ministry of Fisheries and Aquatic Resources Development	
31	Ms.A.D.P.K.De Silva Purchasing officer	19,15.06.2017	Workshop on Procurement Process	Ministry of Fisheries and Aquatic Resources Development	

32	Mr.W.A.S.Perera Management Assistant	19,15.06.2017	Workshop on Procurement Process	Ministry of Fisheries and Aquatic Resources Development	
33	Ms.B.G.S.Kariyawasam Chief Librarian	29.06.2017	SLLA registration fee	Sri Lanka Library Association	Rs.4000.00
34	Dr.V. Pahalawathaarachchi Principal Scientist	17.07.2017	Training Course on Hysteology and Molecular Disease	University Of Peradeniya	Spent Amount for All Participants Rs.25,000.00
35	Mr.S.Epasinghe Scientist	17.07.2017	Training Course on Hysteology and Molecular Disease	University Of Peradeniya	
36	Ms.M.R.L.Thantirige Scientist	17.07.2017	Training Course on Hysteology and Molecular Disease	University Of Peradeniya	
37	Mr.Janaka Pushpakumara Research Assistant	17.07.2017	Training Course on Hysteology and Molecular Disease	University Of Peradeniya	
38	Mr.K.Milan Indika Lab Attendant	17.07.2017	Training Course on Hysteology and Molecular Disease	University Of Peradeniya	
39	Ms.G.S.Chathurika Research Assistant	28.,27.07.2017	Course of Internal Auditing of the Laboratory Management System of ISO / IEC 17025: 2005	Sri Lanka Accreditation Board for Conformity Assessment	Rs.9387.76
40	Ms.Subashi Gallage Research Assistant	28.,27.07.2017	Course of Internal Auditing of the Laboratory Management System of ISO / IEC 17025: 2006	Sri Lanka Accreditation Board for Conformity Assessment	Rs.9387.76
41	Ms.Dinusha Thilini Research Assistant	28.,27.07.2017	Course of Internal Auditing of the Laboratory Management System of ISO / IEC 17025: 2007	Sri Lanka Accreditation Board for Conformity Assessment	Rs.9387.76
42	Mr.M.R.S.P. Senevirathne Helper	31,24,14.07.20 17 - 28.08.2017	MS Word, Excel, Internet & Email usage	Skill Development Fund Limited	Rs.15000.00

43	Mr.S.P.Senevirathne Helper		MS Word, Excel, Internet & Email usage	Skill Development Fund Limited	Rs.15000.00
44	Mr.Dilshan Sadaruwan Helper		MS Word, Excel, Internet & Email usage	Skill Development Fund Limited	Rs.15000.00
45	Ms.P.B.Nethmi Kaveesha Helper		MS Word, Excel, Internet & Email usage	Skill Development Fund Limited	Rs.15000.00
46	Ms. H.S.I.P.Fernando Management Assistant	28.07.2017to Every Friday 3 months	Certificate Course in English Language	Skill Development Fund Limited	Rs.15000.00
47	Ms. M.B.F. Suhadha Helper	28.07.2017to Every Friday 3 months	Certificate Course in English Language	Skill Development Fund Limited	Rs.15000.00
48	NARA STAFF	21,20,14,13.10. 2017	Course on annual stock analysis and disposal procedures	Skill Development Fund Limited	Rs.22000.00
49	Mr.R.A.N.Chamara Development Officer (Project)	12.10.2017	Final Accounts Financial Statement	Prage Institute	Rs.6000.00
50	Ms.W.K.M.Kumari Book Keeper	12.10.2017	Final Accounts Financial Statement	Prage Institute	Rs.6000.00
51	Dr.G.J.Ganegamaarachchi Principal Scientist	26.10.2017	Conference on Packaging Technology (Packaging Clinic)	Sri Lanka Institute of Packaging	Rs.6000.00
52	Ms.Pradeepa Jayasinghe Senior Scientist	26.10.2017	Conference on Packaging Technology (Packaging Clinic)	Sri Lanka Institute of Packaging	Rs.6000.00
53	Ms.Thushini Hemachandra Scientist	26.10.2017	Conference on Packaging Technology (Packaging Clinic)	Sri Lanka Institute of Packaging	Rs.6000.00
54	Mr.S.Thiruchandaran Helper	26.10.2017	Conference on Packaging Technology (Packaging Clinic)	Sri Lanka Institute of Packaging	Rs.6000.00
55	Ms.D.R.Herath Senior Scientist	10.11.2017	Workshop on Biostatistics	University Of Kelaniya	Rs.3000.00

56	Dr.H.M.P.Kithsiri Deputy Director General (Research & Development)	19.12.2017	One day Workshop on Processing Project Proposals	Ministry of Fisheries and Aquatic Resources Development	Free of Charge
57	Mr.A.B.K.Gunarathne (Director / Monitoring & Evaluation)	19.12.2017	One day Workshop on Processing Project Proposals	Ministry of Fisheries and Aquatic Resources Development	
58	Dr.V.Pahalawaththaara chchi Principal Scientist	19.12.2017	One day Workshop on Processing Project Proposals	Ministry of Fisheries and Aquatic Resources Development	
59	Dr.G.Ganegamaarachc hi Principal Scientist	19.12.2017	One day Workshop on Processing Project Proposals	Ministry of Fisheries and Aquatic Resources Development	
60	Mr.K.A.W.S.Weeraseka ra Senior Scientist	19.12.2017	One day Workshop on Processing Project Proposals	Ministry of Fisheries and Aquatic Resources Development	
61	Ms.W.D.W.M.R.V.S. Aluvihare Scientist	22,20.12.2017	Current Analysis of Data Science	University of Peradeniya	Rs.3000.00
62	Mr.H.B.G.U.M. Wimalasiri Scientist	22,20.12.2017	Current Analysis of Data Science	University of Peradeniya	Rs.3000.00
63	Ms.T.C.Balawardhane Scientist	22,20.12.2017	Current Analysis of Data Science	University of Peradeniya	Rs.3000.00
64	Mr.C.S.Peris Assistant Director-HR	2017	Post Graduate Course (MSc)	University Of Colombo	Rs.160500.00
65	Mr.K.A.W.S. Weerasekara Senior Scientist	2017	PhD Degree in Environmental Management	University Of Kelaniya	Rs.35,000.00
66	Mr.R.K.A.Ariyarathne Hydroghrapic Surveyer	2017	MSc Surveying Science Post Graduate Course	University Of Sabaragamuwa	Rs.260000.00
67	Mr.M.Gammanpila Senior Scientist	2017	PhD Degree in Zoology	University Of Kelaniya	Rs.110000.00
68	Mr.K.A.W.S. Weerasekara Senior Scientist	2017	PhD Degree in Environmental Management	University Of Kelaniya	Rs.120000.00

69	Ms.V.K.G.Jayasena Administrative Officer (Admin)	18.11.2017	Diploma in Office Management	Sri Lanka Institute of Administration	Rs.70000.00

Foreign Trainings/Workshops

No.	Name & Designation	Country	Purpose	Period
1	Mr. U.S.P.K. Liyanage Scientist	Sweden	Population Assessment of Cetaceans Project	11.01.2017 – 14.01.2017
2	Mrs. B.H.B. Jayamali Cartographer (ENC)	Thailand	Electronic Navigation Chart (ENC) Quality Assurance (QA) Training course	29.01.2017 – 04.02.2017
3	Dr. R.P.P.K. Jayasinghe Senior Scientist Mr. S.K.S. Liyanarachchi Director/ Service and Operation Mr. S.S. Gunasekara Scientist Mr. U.W.S. Adikari Research Assistant	Norway	Technical Assistance to improvement Management of the Fish Resources in Sri Lanka	05.02.2017 – 27.02.2017
4	Dr. V. Pahalawaththaarachchi Principal Scientist	UAE	03rd Meeting of Signatories (MOS3) to the Dugong MOU & Seagrass and Dugong Technical Workshop	12.03.2017 - 17.03.2017
5	Mr. B.K.K.K. Jinadasa Senior Scientist	Japan	Mercury Monitoring Training Course for 02 Laboratory Technicians	11.03.2017 – 18.03.2017
6	Dr. H.M.P. Kithsiri Deputy Director General (Research & Development)	Norway	Invitation to the Official Naming Ceremony for the Research Vessel Dr. Fridtjof Nansen	22.03.2017 – 25.03.2017
7	Dr. Anil Premaratne Chairman Mr.S.U.P. Jinadasa Principal Scientist	USA	Invitation for the signing ceremony of a Memorandum of understanding (MOU) between the National Aquatic Resources Research and Development Agency (NARA), Sri Lanka, and University of Notre Dame, USA, on Indian Ocean Research	22.03.2017 – 01.04.2017
8	Mr. N.B.P. Punyadewa Senior Scientist	Spain	Joint Tuna RFMOFAD Working Group Meeting	17.04.2017 – 23.04.2017
9	Mr.S.U.P. Jinadasa Principal Scientist	China	WESTPAC Scientific Conference to present Scientific Papers	16.04.2017 – 23.04.2017
10	Mr.A.N.D. Perera Chief Hydrographer	Monaco	19th International Hydrographic Conference – 1st Session of the IHO Assembly.	23.04.2017 – 30.04.2017
11	Mr. J.S. Jayanatha Scientist Mr. C.B. Madagedara Scientist	China	Mariculture, Aquafeed Production and Disease Control and Prevention for Developing Countries	05.05.2017 – 01.07.2017

	Mr. N.W. J. Pushpakumara Research Assistant Mr. M.S.M. Fahim Research Assistant			
12	Mrs. A.M.A.N. Adikari Scientist Mr. T.A.D.W. Karunarathna Development Officer (Project) Ms. R.L.D. Liyanage Research Assistant	China	Fish Seed production and Feed Development for Developing Countries	08.05.2017 - 09.06.2017
13	Mrs. P.A.M.J. Wijepala Research Assistant	China	Mari Culture and Aquatic Products Processing & Marketing for Developing Countries	10.05.2017 – 06.07.2017
14	Mr. K.G. Ruwan Research Assistant	China	Tilapia Breeding and High – Yield Farming Techniques for Developing Countries	08.05.2017 – 19.07.2017
15	Mr. K.W. Indika Lab Assistant/ Development Officer (Actg) Ms. P.D.P. Niroshani Research Assistant	China	Training – Data Base Management FIO – NARA Bilateral Project	12.05.2017 – 19.05.2017
16	Dr. K. Arulananthan Principal Scientist	China	Invitation to attend the Regional Workshop on the contribution of oceanographic data and information management and exchange to Ocean and Sustainability ad SDG – 14	14.05.2017 - 19.05.2017
17	Mr. A.B.A.K. Gunaratne Director (Monitoring & Evaluation)	Kuwait	Sixth Session IOC Regional Committee for Central Indian Ocean (IOCINDIO-VI)	23.05.2017 – 27.05.2017
18	Mr. B.C.W.Iddamalgoda Director General	Norway	1st Meeting of the Parties to the 2009 FAO Agreement on port State Measures to prevent, Deter and Eliminate Illegal, Unreported and Unregulated Fishing, And 1st Meeting of the Ad- Hoc Working Group	28.05.2017 – 03.06.2017
19	Mr. J.A. Jayathissa Research Assistant Mrs. G.R.H. Rupika Development Officer (Project)	China	Sustainable and Intensive Aquaculture for Asian Countries	14.06.2017 – 10.08.2017
20	Mrs. K.H.K. Bandaranayaka Scientist	Japan	Good Practices on Co – Management of Coastal Fisheries	17.06.2017 – 20.08.2017

21	Dr. Anil Premaratne Chairman	USA	High Level United Nations Conference to Support the Implementation of SDG 14: Conserve and Sustainably Use the Oceans, Seas & Marine Resources for Sustainable Development	04.06.2017 – 09.06.2017
22	Mr. M.I.G. Rathnasooriya Scientist	Maldives	7th Working Party on Neritic Tunas	08.07.2017 – 14.07.2017
23	Mr.S.R.C. Ranaweera Deputy Hydrographer	Egypt	17th North Indian Ocean Hydrographic Commission Meeting	18.07.2017 - 22.07.2017
24	Mr. B.K.K.K. Jinadasa Senior Scientist	Singapore	Procurement of Laboratory Equipment Tender No :NPA/SBD/GOODS/01 GCMS Overseas Training in Singapore.	18.07.2017 – 21.07.2017
25	Dr. S.S.K. Haputhantri Principal Scientist	Maldives	Indian Ocean Coastal States Meeting on Allocation Principles	15.08.2017 – 17.08.2017
26	Mr. S.S. Gunasekara Scientist	India	Training Course : GIS Application for Coastal Zone Management	26.08.2017 - 02.09.2017
27	Mrs. Y.M.R.N. Kumari Hydrographic Surveyor	Korea	Training for Ocean Observation and Hydrographic Surveying	30.08.2017 - 24.09.2017
28	Dr. H.M.P. Kithsiri Deputy Director General (Research & Development)	Taiwan	AARDO – ROC International Workshop on "Aquaculture Technology and Industry Development"	17.09.2017 - 23.09.2017
29	Mr. K.H.M.L. Amaralal Principal Scientist	Iceland	World Sea Food Congress	08.09.2017 – 17.09.2017
30	Dr. H.B. Jayasiri Principal Scientist	Tailand	WESTPAC Training Workshop on Distribution, Source, Fate and Impacts of Marine Microplastics in Asia and the Pacific,	19.09.2017 – 23.09.2017
31	Mr. S.R.C. Ranaweera Deputy Hydrographer	South Africa	North Indian Ocean Hydrographic Commission (NIOHC) Capacity Building Work Programme: MSI Training Course, Fish Hoek,	04.09.2017 – 09.09.2017
32	Mrs. W.A.A.P. Wijesundara Hydrographic Surveyor	Belgium	Training Event "Using the Copernicus Marine data Stream for Ocean Applications"	03.09.2017 – 09.09.2017
33	Mr. RA.M. Jayathilake Scientist Mr. S. J. W. W. M. M. P. Weerasekara Scientist	Spain	13th Working Party on Ecosystems and Bycatch (WPEB 13) 15th Working Party on Billfish (WPB 15)	02.09.2017 – 10.09.2017 09.09.2017 – 16.09.2017
34	Dr. H.M.P. Kithsiri Deputy Director General (Research & Development)	Australia	Nomination for Participation for a Two – day Seafood Industry Conference,	25.09.2017 - 30.09.2017
35	Mrs. A.S.L.E. Corea Scientist	China	2017 Seminar on Aquatic Animal Health Management and Quarantine	09.09.2017 – 28.09.2017

	Mrs. M.T.R. Lasanthi Scientist Mr. W.A.L. Wickramasinghe Research Assistant		for Countries along the "Maritime Silk Road"	
36	Mr. D.A. Athukorala Principal Scientist	Nepal	Farm – made feed for sustainable aquaculture development in South Asia: opportunities, challenges and policy intervention	09.10.2017 – 14.10.2017
37	Dr. S.S.K. Haputhantri Principal Scientist	Seychelles	08th Working Party on Methods (WPM 08) and 19th Working Party on Tropical Tunas (WPTT 19)	12.10.2017 – 23.10.2017
38	Dr. V. Pahalawaththaarachchi Principal Scientist	China	ECSA 20174 Conference Where Land Meets Ocean : The Vulnerable Interface	15.10.2017 – 21.10.2017
39	Mr. H.M.T.C. Madusanka Scientist Mrs. J.K.P.C. Jayawardana Scientist Mr. V.S. Gunarathne Research Assistant	China	2017 Seminar on ICM Promoting Comprehensive Economic Strength of Maritime Cities for Developing Countries	22.10.2017 – 12.11.2017
40	Dr. H.A.C.C. Perera Senior Scientist Mrs. K.H.K. Bandaranayaka Scientist	India	Regional Dialogue on Highly Migratory Fish Species in the Bay of Bengal and 11th Indian Fisheries & Aquaculture Forum	20.11.2017 – 25.11.2017
41	Mr. P.A.D.A. Kumara Senior Scientist	Indonesia	IORA Workshop on "Marine Aquaculture and Fish Health Management"	21.11.2017 – 28.11.2017
42	Dr. K. Arulananthan Principal Scientist	China	Speakers for Workshop on Marine Disaster Prevention and Mitigation	02.11.2017 – 05.11.2017
43	Dr. K. Arulananthan Principal Scientist Dr. W.D.N. Wickramaarachchi Senior Scientist	China	Marine Science Research by the Chinese Scientific Research Vessel XIANG YANG HONFPO/ A 03 in the Exclusive Economic Zone of Sri Lanka	05.11.2017 – 11.11.2017

Court Cases

Cases Filed Against the Agency in the Labour Tribunal Colombo

No	The Case Number	The Complainant	Present Status
01	Case No- 01/33/2016	Ms.Achala Ruwanthi Wanigasekara No- 40, Weerasinghe Mawatha, Waragoda,Kelaniya	The Case has been continued .

Cases Filed Against the Agency in the Sri Lanka Human Rights Commission

No	The Case Number	The Complainant	The Respondent	Present Status
01	HRC/MT/127/17/5	Mr.J.B.Alahahapperuma No-08, Mudalindha Piriwena Road, Heennatiya, Matara.	Chairman, National Aquatic Resource Research & Development Agency, Crow Island, Mattakkuliya, Colombo 15	The Case has been continued.
02	HRC/3222/16	01. Mr.A.A.Suresh 02. Mr.R.C.C.Perera	Director General, National Aquatic Resource Research & Development Agency, Crow Island, Mattakkuliya, Colombo 15	A report has been submitted on behalf of the respondent. The Case has been Continued.
03	HRC/3120/14	Mr.T.K.D.Thennakoon No-15, Vishaka Road, Gampaha.	Chairman, National Aquatic Resource Research & Development Agency, Crow Island, Mattakkuliya, Colombo 15	The Sri Lanka Human Rights Commission ruled that the fundamental rights of the Complainant (The Article 12 (I) of the constitution of Sri Lanka) had been breached by the Respondent. The Governing Board had recommended that the matter to be referred to the Attorney General for advice or opinion.
04	HRC/3573/17	Mr.D.D.P.L.Dahanayake No- 120, Palliya Road, Brandiyamulla, Gampaha	• Chairman, National Aquatic Resource Research & Development Agency, Crow Island, Mattakkuliya, Colombo 15 • Director General, National Aquatic Resource Research & Development Agency, Crow Island, Mattakkuliya, Colombo 15	The commission has ruled that the fundamental rights of the Complainant have not been violated by the respondent.

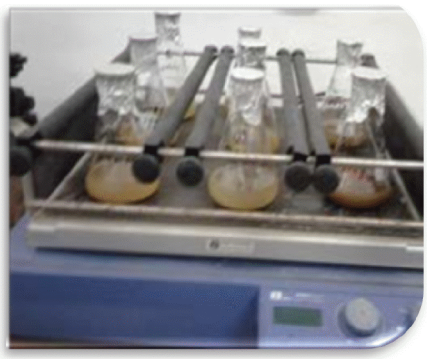
05	HRC/4443/16	Mr.K.W.Indika No-301/03/01 B, Gagula Road, Kothalawala, Kaduwela	• Secretary National Aquatic Resource Research & Development Agency, Crow Island, Mattakkuliya, Colombo 15 • Director General, National Aquatic Resource Research & Development Agency, Crow Island, Mattakkuliya, Colombo 15 • Administrative Officer (Human Resources) National Aquatic Resource Research & Development Agency, Crow Island, Mattakkuliya, Colombo 15	The commission has ruled that the fundamental right of the Complainant have not been violated by the respondent.

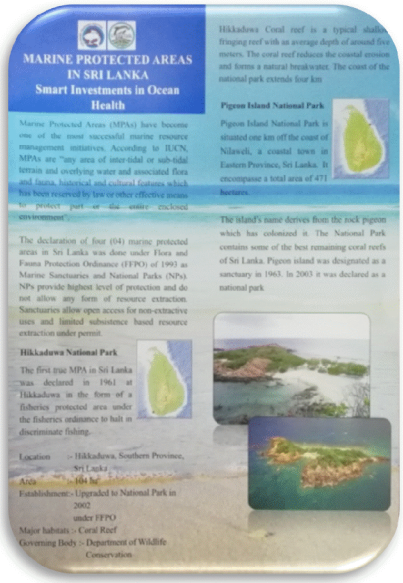
Welfare Activities

Annual new year festival and Christmas day celebrated. In addition to that transport facilities provide to the staff to make easy.

ENVIRONMENTAL STUDIES DIVISION









5. RESEARCH DIVISIONS

5.1 ENVIRONMENTAL STUDIES DIVISION

Head of the Division:

January to July 2017	: Mr. S.A.M. Azmy
August to December 2017	: Mrs. K.A.W. S. Weerasekara

Overview of the year

The Environmental Studies Division (ESD) has been conducting research since 1986 as a small unit consisting of three officers. The division is responsible for considering the environmental aspects related to water quality and aquatic ecology.

Scientists in ESD conduct research, develop technology, and perform analysis to understand and assess responses of different ecosystems at the environment-human interface and the consequences of environmental pollution and environmental strategies. Over years, the division has expanded its capacities in wide range environmental fields and has become a major division which conducting environmental research on aquatic field in Sri Lanka.

Today the division provides a comprehensive range of environmental monitoring and consultancy services to help industries, developers and the government projects to fulfil their legal obligations and to comply with environmental regulations. ESD expert team provides island wide research coverage and services including site investigation, sampling and analysis, monitoring, interpretation and consultancy in diverse environmental fields.

Divisional staff consists of three senior scientists including Head of the Division and seven scientists in fulfilling the research activities and other major tasks. Moreover, a development officer, two research assistants, a word processing operator, two laboratory assistants, and a helper are also representing the divisional staff to facilitate the research and development activates.

During the year of 2017, the division successfully completed a huge project of “Preparation of Environmental Profiles of five lagoons” with the coordination of other research divisions of NARA and this project was highlighted in the Ministry of Fisheries as well. Other than that, the division carried out six research projects, which were mainly focused on environmental related topics and for the development of the fisheries industry including a project to carter the emergencies such as fish kills and oil spills, and a project to improve the quality of the laboratory.

Programme		Project		Allocation (Rs.)Mn	Officers Responsible	Period	
						From	To
1	Conservation and Management	1.17	Development of Environmental Profile to Lagoons in Sri Lanka	5.0	Dr. W.D.N. Wickramaarachchi Dr. A.A.D. Amarathunga, N.D.Hettige, B.R.C.Mendis, S.R.C.N.K. Narangoda, M.D.S.R.Maddumage, J.K.P.C.Jayawardane	January 2017	December 2017
2	Conservation and Management	5.2	Study of pollutant (pesticide) behavior of in the rivers and development of low cost Methodologies and technologies to improve quality of inland water resources to enhance the inland fisheries.	2.5	S.A.M. Azmy, K.A.W.S. Weerasekara, Dr. W.D.N. Wickramaarachchi, Dr. A.A.D. Amarathunga, N.D.Hettige, B.R.C. Mendis, S.Maddumage, Pavithra Jayawardena, C.Narangoda	January 2017	December 2017
3	Conservation and Management	5.3	Genotoxicity Screening of selected Reservoirs and Drinking Water Wells Located in the North Central Province (NCP) of Sri Lanka using Plant and Fish Based Bioassays.	1.5	K.A.W.S. Weerasekara, S.A.M Azmy, N.D.Hettige, S.R.C.N.K. Narangoda	January 2017	December 2017
4	Conservation and Management	5.4	Identification of the Operational Impacts of cooling water system of Norochcholai Coal Power Plant	1.0	M.D.S.R.Maddumage, S.A.M Azmy, Dr.W.D.N.Wickramarachchi, Dr.A.A.D.Amaratunga, K.A.W.S. Weerasekara, N.D.Hettige, B.R.C. Mendis, J.K.P.C. Jayawardane S.R.C.N.K. Narangoda	January 2017	December 2017
5	Conservation and Management	5.5	Project Title: Investigation of causes for emergency incidents	0.2	S.A.M.Azmy, Dr. A.A.D. Amarathunga, Dr. W.D.N. Wickramaarachchi, K.A.W.S. Weerasekara,	January 2017	December 2017

			such as oil spills, algal blooms and fish kills, fishing disputes (Emergency studies)		N.D.Hettige, B.R.C.Mendis, M.D.S.R.Maddumage, J.K.P.C. Jayawardane, S.R.C.N.K. Narangoda		
6	Conservation and Management	6.3	Quality improvements to ESD laboratory and test & advisory services	1.0	S.A.M Azmy, K.A.W.S. Weerasekara, Dr.W.D.N.Wickramarachchi, N.D.Hettige, M.D.S.R.Maddumage, J.K.P.C. Jayawardane S.R.C.N.K. Narangoda	January 2017	December 2017

PROJECT NO: 1.17
PREPARATION OF ENVIRONMENTAL PROFILE FOR FIVE LAGOONS/ESTUARIES

Objectives:

- The objective of this study was to investigate in following key points to prepare an environmental profile for Kokkilai, Puttalam, Negombo, Rekawa and Panama Lagoon.

- To study the current biological, physical and socioeconomic status of the lagoons and their catchment. Identifying the main ecosystem and other ecosystem types, inventories of plant and animal diversity and identifying major drivers of change were the major objectives of this study.

- To identify management priorities and make effective policy recommendations related to coastal water pollution.

- To provide recommendations for biodiversity conservation of lagoons and their catchment.

- To find ways and means of increasing fish production by introducing culture based fisheries while conserving the valuable ecosystem for future.

- Prepare environmental profile to provide viable recommendations for management plan towards sustainable utilization of lagoons.

Methodology:

Main study procedure followed to preparation of the development plan

- Assessment of ecosystems, terrestrial and aquatic fauna, water quality, aquatic pollution(ESD)
- Assessment of physical oceanographic condition (Oceanography)
- Assessment of geomorphology, geology and hydrology (NHO)
- Assessment of fisheries aspects and economically important species of fish (MBRD)
- Assessment of socioeconomic status of lagoon in relation to fisheries (SED)

Output:

Preparation of environmental profiles and management plans for Kokkilai, Negombo, Puttlam, Rekewa and Panama Lagoons.

Outcome:
Development and management of lagoons to use extractive and non-extractive resources sustainably.

Recommendations:
In order to provide recommendations, five lagoons were studied to its maximum level possible and the recommendations were listed in each profile in recommendation section with management plan for its sustainable utilization. Recommendations were varied from lagoon to lagoon, which could be categorized as follows;

Administrative aspects

- Identification and demarcation of their ecological or existing boundaries.
- Strengthening of regulatory bodies to manage lagoons.
- Advise to legal actions to reclaim the ecologically important places which were encroached
- Address overexploitation and conflict related to fisheries
- Mapping of all the ecosystems identified in each lagoons and restrictions will be imposed to mitigate destructions in future.

Constructions and engineering work

- Construction of jetty in selected landing site
  - Two Jetties for Kokkilai
  - A jetty for Rekawa

- Construction of bridge
  - Kapuhenwala bridge

- Construction of bridge and causeway facilitating enough water exchange to link Eastern main road, Pulmudai to Mulathuv via Jayasinghepura avoid unnecessary lengthy roads from Pulmudai to Mulativu via Halambewewa, Sinhaputa, Janakapura. This could be more helpful for the development of the fisheries industry and general living conditions of the Kokkilai villagers.

- Expand Pitipana road and Bridge or new bridge to link pitipana to hotel road in Negombo lagoon

- Cleaning of lagoons- dredging of identified place if any
- Construction of common requirements of the villages such as sanitary facilities water supply, electricity, community hall and other identified specific requirements.
- Establishment of a fish marketing centre
- Introduce proper garbage disposal system

Development activities

- Identification of potential aquaculture zones for each lagoon
- Identification of potential species for aquaculture for each lagoon
- Identification of fish farmers and their capacities for each lagoons
- **Promote Nature Based tourism:** Several tourism related activities can be promoted within this area. Bird and wildlife watching, camping, boat tours and nature trails are some of the possible tourism related activities for the area. Tourism related infrastructure can be developed by the DWC (e.g. camp sites, nature trails and forest lodges), private sector (e.g. accommodation and nature tours) and community members (e.g. guest houses, home stay and boat rides).

Awareness programmes

- For fishermen, village dwellers and responsible government officers in the area
- on waste disposal, co-management concepts, fishing and conservation requirement of the each lagoon

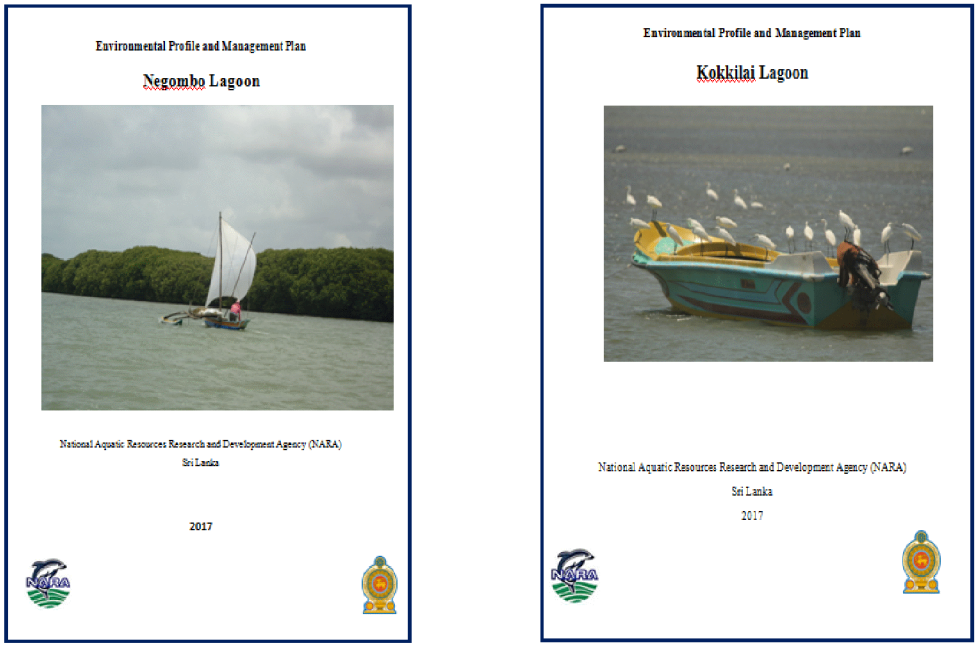
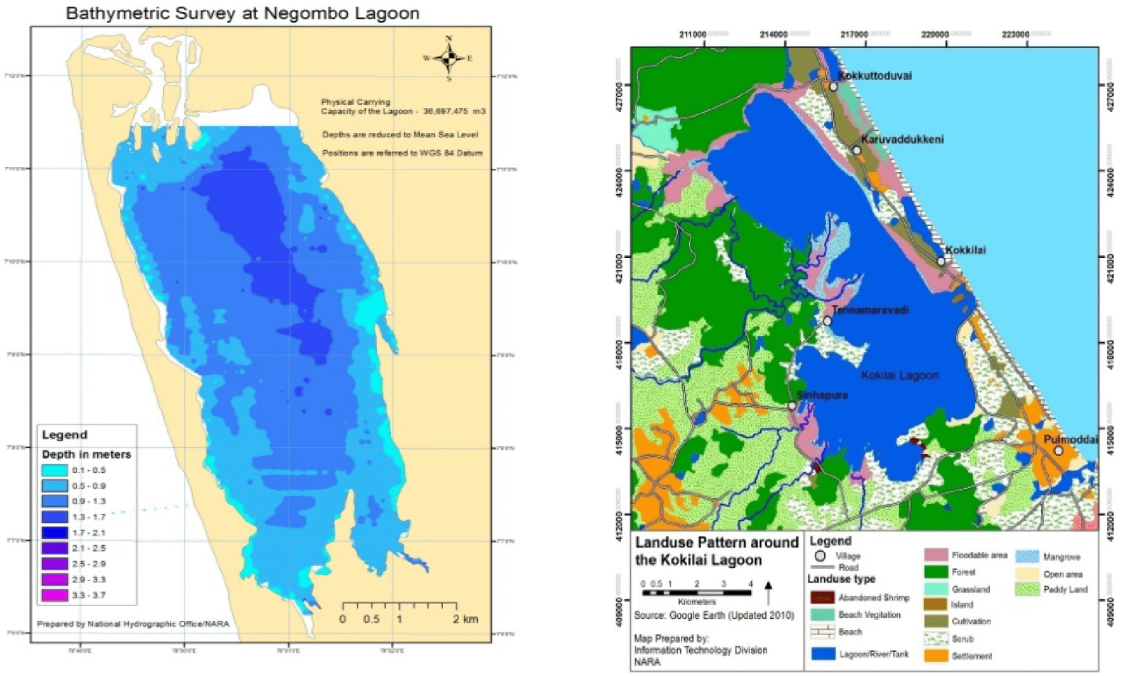


Figure 1 : Pictures of prepared Environmental Profile's cover page

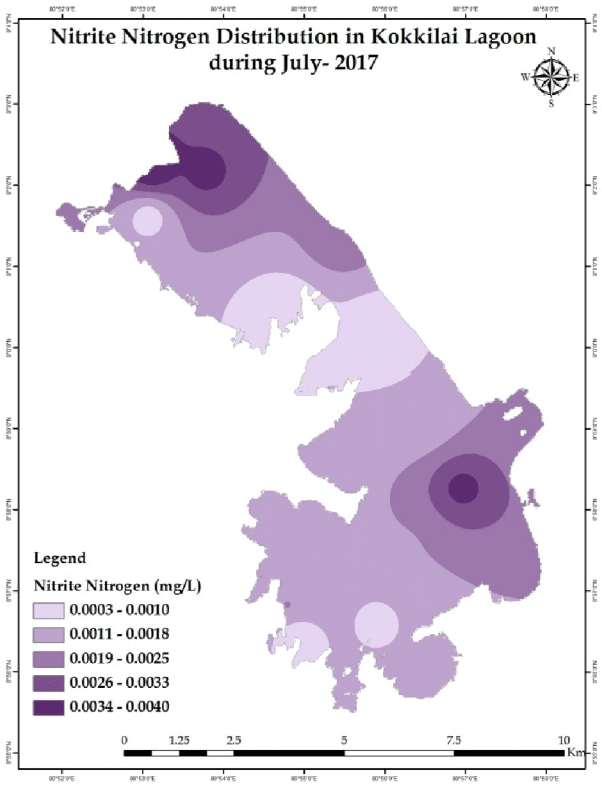
ISBN Numbers for prepared environmental propiles;

- Kokkilai Lagoon : ISBN 978-955-8014-18-9
- Negambo Lagoon : ISBN 978-955-8014-19-6
- Puttalam Lagoon : ISBN 978-955-8014-20-2
- Rakawa Lagoon : ISBN 978-955-8014-22-6
- Panama Lagoon : ISBN 978-955-8014-21-9



(a) (b)

Figure 2 :(*a and b*): :*(a)* Bathymetric Survey at Negambo Lagoon (b) Land use map Kokkilai lagoon



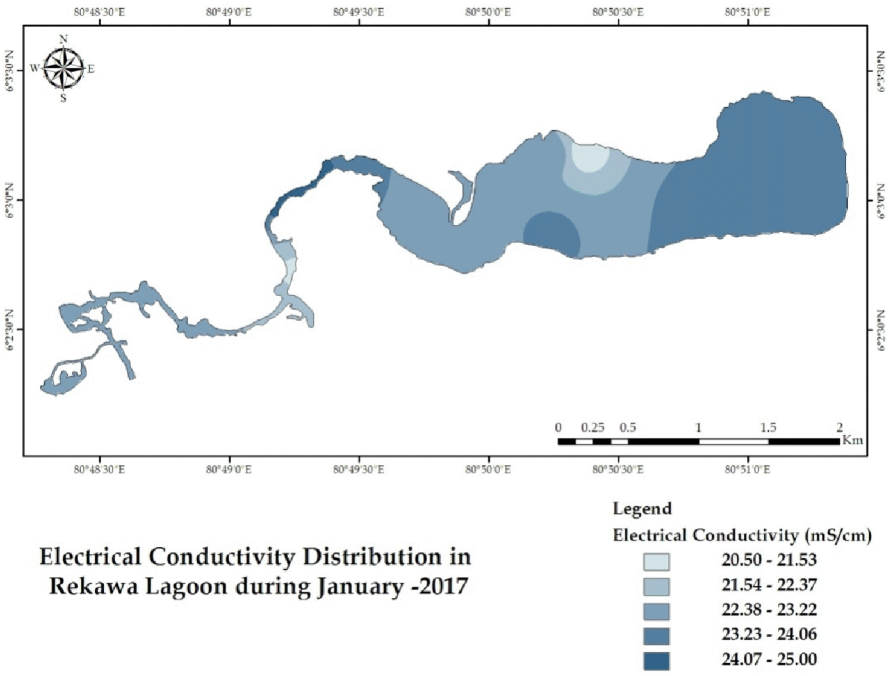


Kapuhenwala Bridge



Illegal encroachment within the mangrove forest

Figure 1: Issues identified in Rekawa lagoon



Electrical Conductivity Distribution in Rekawa Lagoon during January -2017

Figure 4 : Water quality maps

Progress : Financial: 75% Physical: 95%

PROJECT NO: 5.2

STUDY OF POLLUTANT (PESTICIDE) BEHAVIOR OF IN THE RIVERS AND DEVELOPMENT OF LOW COST METHODOLOGIES AND TECHNOLOGIES TO IMPROVE QUALITY OF INLAND WATER RESOURCES TO ENHANCE THE INLAND FISHERIES

Background

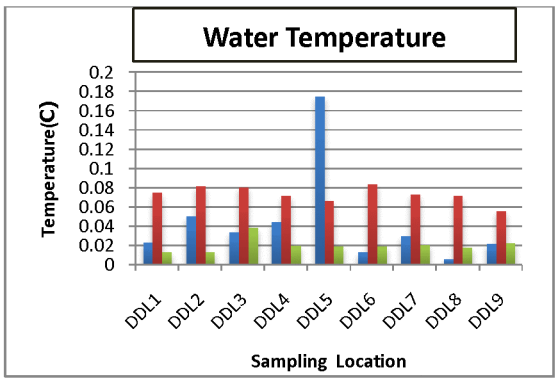
Aquatic environments are mainly threatened due to various anthropogenic activities, and are subjected to over use and contaminated with untreated waste water/fertilizer/pesticide/waste/ etc. These water pollutants are directly discharged in to streams and rivers and finally ended up in reservoir sediment or in the coastal zone of the country. Rapid land use transformation of forest areas to agriculture lands is a common practice mainly in developing countries, which led to increase addition of agrochemicals such as fertilizer, pesticide, suspended sediment etc., to environment. Most of the contaminants are transported from farm lands to downstream and finally ended up with reservoirs, coastal areas through stream/rivers. Also, it may bio accumulate and finally concentrated in the human body via food chain. Therefore, it is very important to understand the pesticide/contaminant behaviour in the environment/aquatic environment to take precautionary measures.

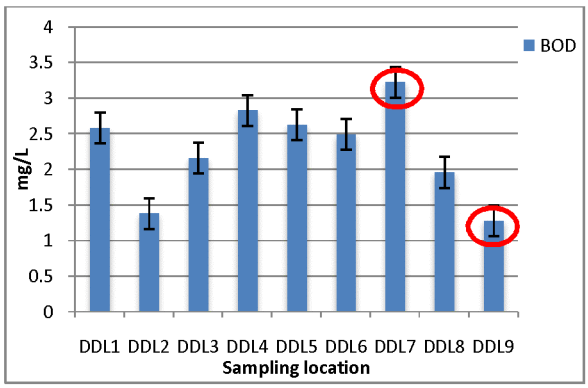
Objectives:

- To assess water quality, pollutant & toxic agents and diversity of the different faunal categories in the river basin
- To facilitate the improvement of inland /coastal aquatic environment using new methodologies /technologies
- To elucidate the pollutant behavior in the aquatic environment

Results:

It reveals that Benthara river estuary (deduwa) has low productivity with following results. Several water quality parameters of deduwa estuary are as Dissolve oxygen (7.49 ± 2.55 mg/L), Salinity (8.49 ±2.77 mg/L), total suspended solids (14 ± 7.66 mg/L), biological oxygen demand (3.22 ± 1.32 mg/L) and chemical oxygen demand (3.56 ± 2.14 mg/L). Total 42 individual benthic macro invertebrates were identified only one location and Class Gastropod represented the 71.35% from the total composition. Family Pleuroceridae, *Sphaeriidae* spp was the dominant in benthic abundance. Phytoplankton abundance is 243.74 ± 228.09 No/mL. Benthic macro invertebrate's diversity is 0.832 according to Shannon Weiner Index (H).





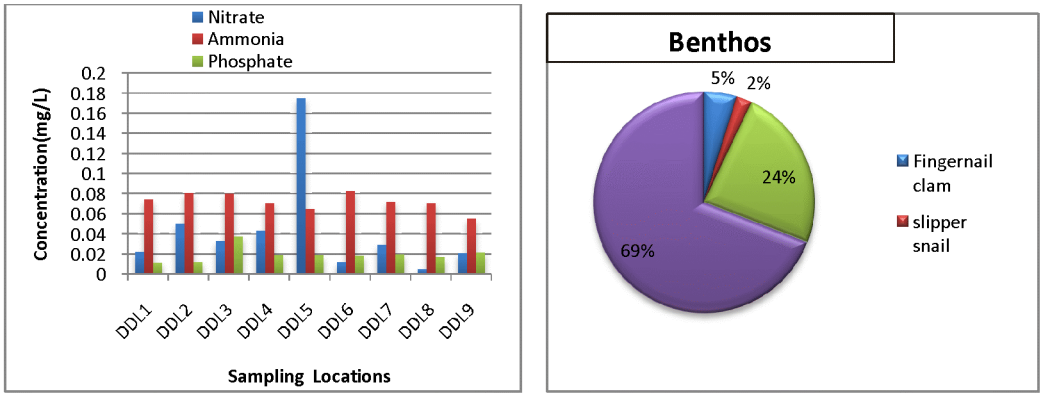


Figure 5 : Results of the water quality Analysis of Dedduwa Estuary

The pesticide degradation with catalyze under simulated artificial sunlight as tested in the laboratory and results shown that the significant amount was reduce.

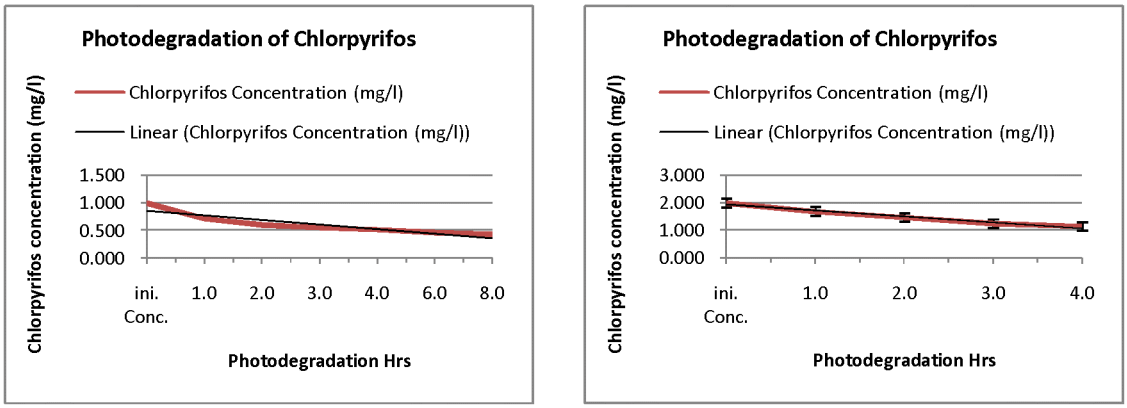


Figure 2: Result of pesticide analysis

Also, *Daphnia magna* and Chlorella was cultured and maintained for the toxicity testing.



Figure 7 : Pictures of Toxicological experiment



Figure 8 : Maintained culture

In addition, waste water reactor for pesticide treatment from the farmlands in Sri Lanka was fabricated and installed at the Ambewela area for continuous monitoring the degradation process in the field. This test will continue to one or two cropping calendar in the next year.



Figure 3: Pictures of Treatment reactor

To understand the performance of this treatment reactor, process should be monitor minimum of two cropping seasons in the field in next year (2018).

Progress : Financial: 108.5% Physical:100 %

PROJECT NO: 5.3

GENOTOXICITY SCREENING OF SELECTED RESERVOIRS AND DRINKING WATER WELLS LOCATED IN THE NORTH CENTRAL PROVINCE (NCP) OF SRI LANKA USING PLANT AND FISH BASED BIOASSAYS.

Officer responsible : Mrs. K.A.W. Shyamali Weerasekara

Problem Statement/ Justifications:

Chronic Kidney Disease of unknown aetiology (CKDu) is currently a major health problem in some parts of Sri Lanka especially in some areas of the North Central Province. Although, aetiology of this disease is still unknown, different hypotheses, including use of agrochemicals such as pesticides (i.e. glyphosate), contamination of heavy metals such as cadmium and arsenic in water, presence of excessive amounts of fluoride in drinking water and additive effect of aluminium by enhancing the absorbance of fluoride, presence of toxins in water and hardness of water etc. have been formulated. However, none of these hypotheses have been fully supported with strong scientific evidence, to prove the causative factor/s for CKDu and the root cause of the disease. It has been commonly observed that, CKDu is caused by multiple factors, likely linked to a combination of environmental factors, diet and nutritional practices, and genetics. Recent epidemiological study conducted in the North Central Region of Sri Lanka, revealed that 92% of the CKDu patients were farmers, while 93% consumed water from shallow dug wells also found that, nearly 87% of the CKDu affected districts use either dug well or tube well water. Therefore, assessment of the potential toxicity of drinking water sources in the NCR region with especial reference to dug wells and tube wells is needed to find out the biological effects associated with the water consumption.

Project Objectives

- To evaluate biological significance of the contaminants in drinking water sources through toxicity (especially cytotoxicity and genotoxicity) screening of drinking water wells using plant and fish based bioassays.
- To assess health status and heavy metal contaminations in reservoir fish species.

Methodology

Research work included two main phases;

- Phase o1 included;
  Characterization of drinking water wells (Dug Wells & Tube Wells) & Reservoir water using physico-chemical methods and evaluation of the potential toxicity using bioassays.
- Phase 02 included;
  Assessing the associations between contaminated load and health status of the selected feral fish species inhabit in the Padaviya Reservoir.

Progress of the project

Sampling and analysis was completed during prolong dry season and wet season for;

- Padaviya Reservoir
- Dug Wells (Medawachchiya)
- Tube Wells (Medawachchiya)

In the Padaviya Reservoir, research work included assessment of associations between contaminant load and health status of the two feral fish species in the reservoir namely *Oreochromis niloticus* (Nile tilapia) and *Ompok bimaculatus* (commonly called as "Pena Walaya").

Results:

- Glyphosate was not detected in any sampling locations of the reservoir water or well water (< 5 µg/L, detection limit).
- Four heavy metals tested for reservoir waters namely Lead (Pb), Cadmium (Cd), Mercury (Hg) and Arsenic (As) were less than the detection limits. (As < 1.0 µg/L, Hg < 1.0 µg/L; Pb < 10.0 µg/L ; Cd < 1.0 µg/L) except one dug well water sample taken during the wet season (Pb was detected & it was within the acceptable limits for drinking as SLSI: 2013).
- Fluoride content of water was ranged from 0.25 to 0.40 mg/L and it was within the standard limits for drinking water quality (WHO 0.6 mg/L) of the reservoir water. However, fluoride was above the standard limits for one CKDu affected people used dug well (3.4 mg/L).
- The detected average concentration of Cd in two selected fish kidney tissues were above the standard limits (>0.05 mg/kg) defined by European Union, regulation number 1881/2006 of 19 December 2006. (Wallaya (0.31 ± 0.21),Tilapia (0.11 ± 0.05)mg/kg .
- However, Cd in fish flesh were not detected in Walaya fish flesh samples and 0.43 mg/kg Cd concentration were detected in only one Tilapia fish flesh sample which was above the standard limits (>0.05 mg/kg) defined by European Union, regulation number 1881/2006 of 19 December 2006 .

Outcome / Indicators:

Expand knowledge of CKDu and identify the causative factor(s) in developing the disease.

- Number of GN divisions and villages covered for the study
  Twenty (20) GN divisions for the questionnaire survey
- Number of toxicity tests conducted
  Total of twelve Plant & fish based bioassay tests
- Number of research papers published

Published two (02) abstracts on

1. Weerasekara, K.A.W.S., Pathiratne, A. and Kithsiri, H.M.P. (2016). Combination of Physico-Chemical Analysis and A Plant Bioassay for Screening Potential Toxicity of Drinking Waters in Selected Dug Wells in Medawachchiya Area, Sri Lanka: A Preliminary Study. In proceedings of the 17th Conference on Postgraduate Research, International Postgraduate Research Conference 2016, Faculty of Graduate Studies, University of Kelaniya, Sri Lanka. p 155.

2. Weerasekara, K.A.W.S., Pathiratne, A. and Kithsiri, H.M.P. (2017). Prevalence of CKDu in Medawachchiya area with special reference to the physical characteristics and source of drinking water NARA Scientific Sessions, p.46.

3. One journal paper on; Prevalence of CKDu in Medawachchiya area with special reference to the physical characteristics and source of drinking water is in progress.

Output:

- Suitable preventive measures with recommendations to reduce the victims of CKD and uplift the economy of the country.

Beneficiaries:

Community of NCP, Fisheries Community, Stake Holders, Researchers and Scientists, Policy makers.



Figure 10 : Questionnaire survey during field visits

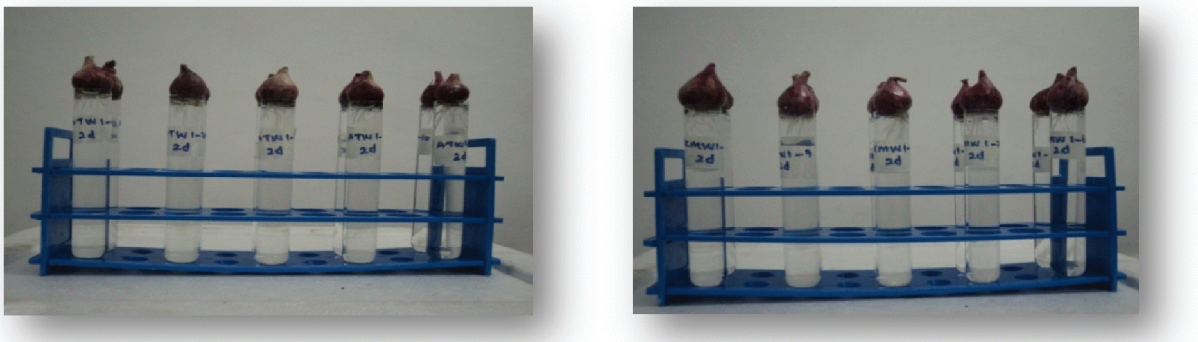


Figure 11 : Plant Bioassays

Progress : Financial: 95.22 % Physical: 96%

PROJECT NO: 5.4

IDENTIFICATION OF THE OPERATIONAL IMPACTS OF COOLING WATER SYSTEM OF NOROCHCHOLAI COAL POWER PLANT

Objectives:

- To Identify the present status of the physical, chemical and biological factors
- To compare current data with baseline conditions stipulated in the EIA.
- To identify the severity of the current condition by comparing it with the prevailing environmental regulations.
- To identify the proposed mitigatory measures, their implementation, effectiveness and to provide recommendations for upgrading present monitoring plan of EIA.

Methodology

The study was carried out from January to December 2017 on monthly basis. The ten sampling locations namely NRP 1 (Near shore Intake culverts), NRP 2 (250 m seaward from the discharge point), NRP 3 (500 m seaward from the discharge point), NRP 4 (750 m seaward from the discharge point), NRP 5 (1 km seaward from the discharge point), NRP 6 (2 km seaward from the discharge point), NRP 7 (Reference point , 2 km seaward and 2 km North to the discharge point), NRP 8 (Intake inside power plant premises) , NRP 9 (Outlet inside power plant premises) and NRP 10 (150 m seaward and 1 km North to the discharge point) were selected for water quality and other biological parameter analysis. Both surface and bottom water quality parameters were measured in selected sampling locations namely NRP 2, NRP 4 and NRP 5. Only surface water quality parameters were measured in all the other locations. Figure 1(a) illustrates the map of the sampling locations. However, water sampling was done along the coastal line and jetty during the rough sea period as given in the Figure 1(b).

Water temperature, Electrical Conductivity (EC), Total Dissolved Solids (TDS), Dissolved Oxygen (DO), Turbidity, Salinity, pH were measured as ***in-situ*** parameters and Nutrients (Phosphate, Nitrate-N, Nitrite-N, Ammonical–N), Biochemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD) and Chlorophyll-a were analysed in the ESD laboratory adopting the standard methods for the Examination of Water and Waste Water (APHA), 22nd edition.

Furthermore, Polycyclic Aromatic Hydrocarbons (PAHs) in water, fish and sediments were analyzed in selected sampling locations. Heavy metals namely, Mercury (Hg), Chromium (Cr), Zinc (Zn), Cadmium (Cd), Copper (Cu) and Arsenic (As) in water, fish tissues and sediment samples were also analyzed in selected locations.

Plankton analysis was conducted during calm sea season in sampling locations NRP 1, NRP 2, NRP 7, NRP 9 and NRP 10 while in NRP 1, NRP 4, NRP 9 and NRP 10 during rough sea period. Plankton samples were collected by filtering 50 L of water collected at a depth of one meter from the surface through 20 µm nylon plankton net. The filtrate was concentrated to 100 mL for each station. Three drops of Lugol's solution was added to each sample to preserve the phytoplankton and 5% formalin solution to preserve the zooplanktons and allowed the organisms to settle. The bottles were covered and properly labeled at each sampling location. Then quantitative analysis was carried out through sub sampling techniques using a Sedgwick rafter cell under the mid power of the microscope. Species were identified to the nearest taxonomic level using the guides.

Ichthyoplankton survey, underwater habitat surveys for benthic and pelagic resources, fishery dependent data collection were carried out by Marine Biological Resource Division, NARA.



(a) **(b)**

Figure 12 : Map of Selected Sampling Locations in Calm Season (a) and Rough season (b)

Results and Observations

Water temperature at the discharge point is always greater than inlet temperature. The average difference between inlet and outlet is 5 °C and the highest difference of 7.4 °C was observed in the month of December. The variation of water temperature in the inlet and outlet during the study period is illustrated in Figure 11.

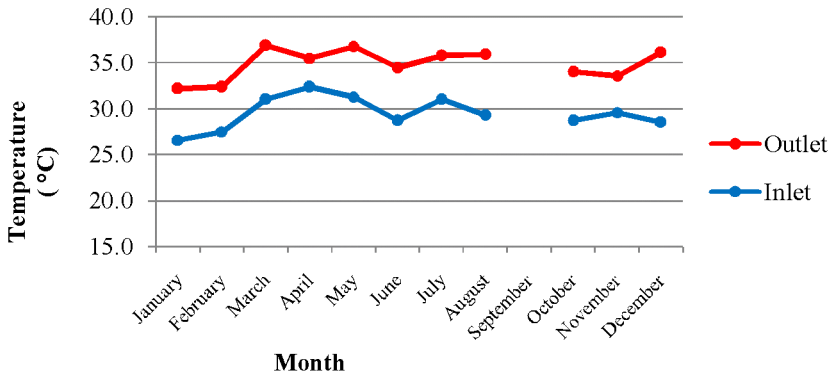


Figure 13 : Temperature Difference in Inlet and Outlet of the Cooling Water System- Norochcholai Coal Power Plant

Highest water temperature recorded at the discharge point of the cooling water system throughout the study period. Water temperature is decreasing with the offshore distance from discharge point and it gets equals the reference point temperature within 750 m to 1 Km offshore from the discharge point Furthermore, higher temperature values observed in the NRP 10 location, which is about 1 km northward to the discharge point in both, calm and rough seasons (Figure 12). In the rough season, temperature at the outlet also reduces with the increasing distance from the discharge point (Figure 13).

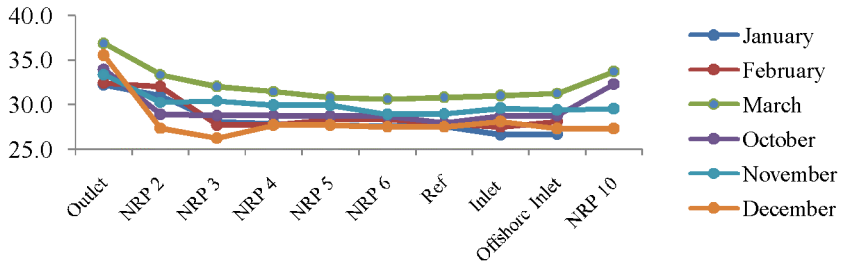


Figure 14 : Variation of water temperature in selected sampling locations in calm sea conditions

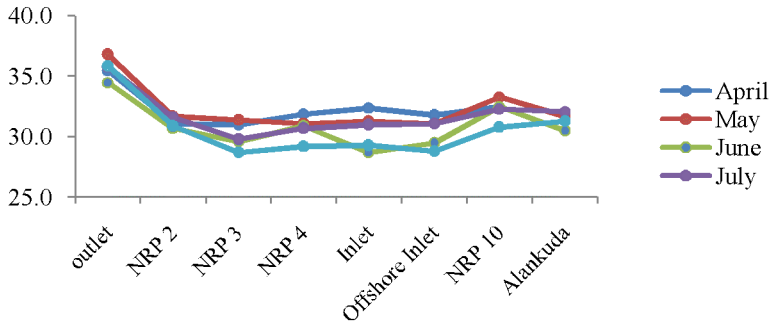


Figure 15 : Variation of water temperature in selected sampling locations in rough sea conditions

According to the results, water temperature in all the selected locations was below the tolerance limits for industrial and domestic effluent discharge in to marine coastal areas (max 45 °C at the point of discharge) of National Environmental (Protection and Quality) Regulations No 1 of 1990 by Central Environmental Authority of Sri Lanka.

The heavy metals namely Mercury (Hg), Copper (Cu), Lead (Pb), Cadmium (Cd), Chromium (Cr) and Arsenic (As) were tested in selected sampling locations in selected months. Sea water samples from NRP 1 and NRP 9 locations were tested for above heavy metals in month of April and the results revealed As 0.001 mg/L (Limit of Reporting (LOR)-0.001) in both locations. Results of the heavy metal analysis of seawater from NRP 1, NRP 3, NRP 8, NRP 9 and NRP 10 conducted in May indicated Cu 0.47 mg/L (LOR-0.01) and As 0.06 mg/L (LOR-0.02) in NRP 10 location. In November, above heavy metals were tested in water, sediment and fish samples. Water and sediment samples were collected at NRP 1, NRP 3, NRP 7, NRP 8 and NRP 9 locations while 5 fish species (*Sardinella*, Yellow Trevallies, Yellowtail Scad, Bigeye Scad and Wolf-herring) were taken for fish tissue analysis. According to the results, none of the heavy metals detected in water or fish samples. However, in sediment samples, Cr (LOR- 0.01) was detected as 4.1 mg/L, 2.9 mg/L, 7.0 mg/L and 3.8 mg/L in NRP 1, NRP3, NRP 7 and NRP 10 respectively.

16 PAHs, published as priority pollutants by United States Environmental Protection Agency (US_EPA) were tested in sea water, fish and sediment samples in selected sampling locations and selected months. According to the results, PAHs were not detected at the given LOR (0.001mg/kg) in any of the water, sediments and fish tissue samples tested.

Lowest DO concentration was detected in the outlet tank and it was less than 5 mg/L in some sampling months. All the other locations had greater than 5 mg/L DO concentrations during the study period. pH level at the discharge location ranged from 6.9 to 8.7 throughout the study period. Low pH levels detected always at the discharge point compared to the cooling water intake. All the other test parameters did not produce significant variation among sampling locations.

According to the analysis of phytoplankton, the lowest total phytoplankton per milliliter was recorded in sampling location NRP 9. Furthermore, sampling location NRP 10 was recorded lower total phytoplankton per milliliter compare to the other sampling locations. A total of 62 phytoplankton species belonging to five classes were identified during the study period. Diatom is the most abundant class which included 44 species. This was followed by Dinophyceae which included 14 species. In addition, two species was included in group of Cynophyceae. The group of Synurophyceae, and Chlorophyceae detected with one species. Zooplanktons observed during the study were belongs to the Arthropoda, Mollusca, Cordata, Protozoa, Annelida, Ciliophora, Nematoda and Rotifera. The total zooplankton per milliliter was also lowest in sampling location NRP 9 compare to the other locations.

A total of 34 fish and shellfish species belong to 16 families were recorded during the study. From that 27 species were identified as edible species.

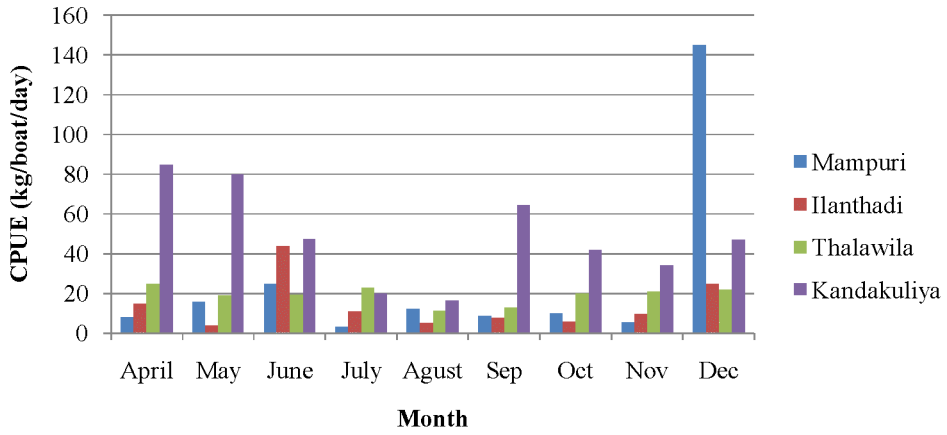


Figure 16 : CPUE variations in different landing sites

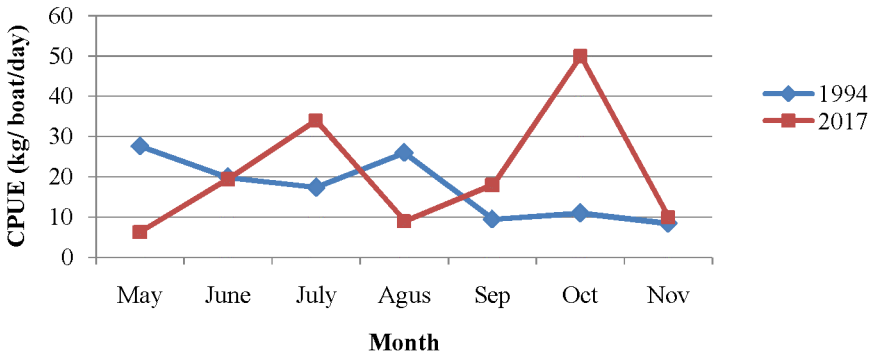


Figure 17 : CPUE variations in Thalawila fish landing site in 1994 & 2017

Bottom set gill nets and small mesh gill nets are the highly used fishing gears in study sites. Minimum and maximum recorded average CPUE values relevant to bottom set gill nets in Thalawila landing site were vary from 6.3- 50 kg/boat/day where minimum value was recorded in May and Maximum value recoded in October. Average CPUE value recorded in 1994 vary from 6.2 - 44.3 kg/boat/day study done by Jayawardene and Dayaratne (1994) in Thalawila coastal area. Further studies should be carried out to determine long term fluctuations of CPUE values in all landing sites. The study could be revealed that fishing distance has been increased. It means that fishermen do fishing in faraway to the beach. That may be due to the changes of the coastal water currents.

There is a significant difference in Ichthiyoplankton abundance in outlets when comparing to the reference point. Average density of fish eggs and larvae was varied from 2-12 individuals/$m^3$and highest density was recorded in April and December in 1km North side to the power plant. But immediately the outlets Ichthiyoplankton density has come closer to value of reference point. This may be due to well mixing of water due to high wave action. It is important to consider impact on water intake than water outlet. Because, 58,000 m^3 of sea water sucked by the inlets wells per hour and according to the calculations $348*10^3$ individual /hour (fish larvae and eggs) are died by the high temperature. This can be affected to coastal fish stocks and to coastal fish catches.

Underwater survey was carried out only in coal unloading site and ship anchorages because of the rough sea condition and limited time frame. According to the survey we observed sandy bottom with high water currents and low abundance of benthic flora and fauna. But several fish species were recorded in sheltered areas of jetty and ship anchorages. There is no coral reef formation within the $1km^2$area and this may be due to high water currents and moving sand.

During the operational activities falling of coal to sea was observed at loading unloading. Long term exposure of coal to marine environment can cause toxicity, smothering, abrasion, reduce availability of light to benthic organisms and clogging respiratory and feeding organs of fish and other organisms.

Fishermen were positively discussed about the job opportunities given by the power plant and there were negative perceptions like limited access to the previous fishing grounds, struggling with Navy and health issues due to coal dust. Some other negative impacts identified during the study are illustrated from figure 16 to 19



Figure 18: Debris collected at the inlet screens. (Huge amount of Bivalves, Gastropods and Molluscs species)

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Figure 19: Agricultural lands affected due to fly ash/coal or other negative effects



Figure 20 : Coal yard without proper wind shield for the whole yard

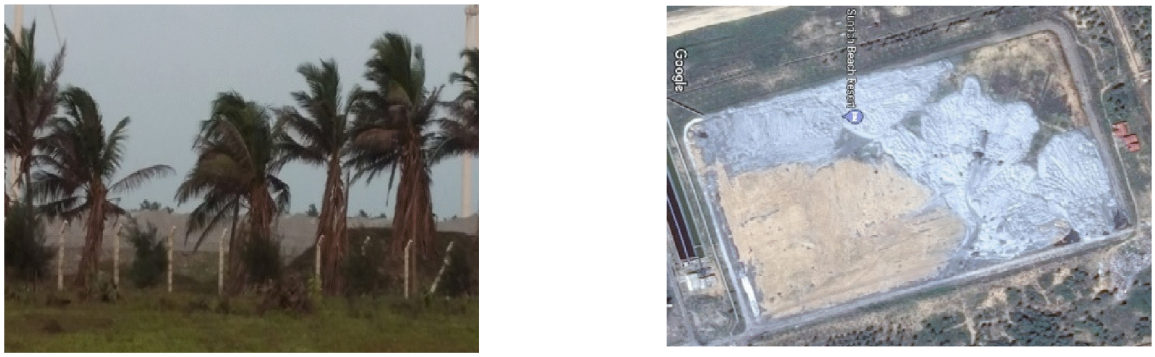


Figure 21: Fly ash is stored in piles without proper management/recycling/reuse

Output

Findings and recommendations of the study will be sent to the Lakvijaya Coal Power Plant, Ceylon Electrically Board and Ministry of Fisheries and Aquatic Resources Development.

Outcome

Ensure clean and healthy aquatic environment by considering the recommendations and implementing relevant mitigatory measures.

Recommendations

- A monitoring committee should appoint and the monitoring program should implement as instructed in the EIA.
- All the mitigatory measures stipulated in the EIA should implement.
- Standards limit for discharge of effluents into marine coastal areas should be thoroughly followed when discharging any effluent from the power plant. The regulations are given in the National Environmental (Protection and Quality) Regulations No 1 of 1990 (Gazetted on 01 February 2008 – Gazette Number 1534/18).
- Sri Lanka does not have specific water quality standards for thermal effluent discharges. Above regulation is a general guideline for industrial and domestic effluents. Therefore, adopting global level standards for cooling water discharge (World Bank standards, EPA standards, etc.) is required for an effective minimization of impacts.
- Continues measurement of temperature in sea water is very important rather than the intermittent measurement of temperature. Therefore, temperature data loggers should deployed in selected locations in the sea to record real time temperature data. NARA recommends installing 5 data loggers in selected locations.
- A model should develop to identify the behavior of the thermal plume and its impacts.
- Real time monitoring station for measuring various water quality parameters should implement in the power plant premises.
- Huge amount of fly ash and bottom ash stored in piles can cause adverse health impacts. Therefore, ash handling and disposal should do considering the mitigatory measures stipulated in the EIA.
- High quality coal, which has minimum impurities, will produce lesser pollutants in the un-burnt condition as well as in the coal combustion. Therefore, importing quality coal with the recommended minimum particle size is a must.
- Un-burnt coal is a marine pollutant and it can reach marine environment during coal unloading from ship, barges and during barge operations. Coal fallings should be prevented when coal loading and unloading.
- Leachate from coal and ash stockpiles, boiler blow- down water, boiler rinse water, effluent from FGD and sewage should checked for harmful contaminants and standard limits before discharge into sea via cooling water system.
- Proper discussion should be maintain among the fishing community, nearby villagers and CEB management to identify the issues, possible solutions and increase CSR component to the affected community.
- Aquatic organisms drawn into cooling water system are impinged or entrained and finally get killed. Therefore, intake velocity should be set to a minimum and installation of barrier nets or similar

technologies should consider for preventing, minimizing and controlling environmental impacts associated with water withdrawal.

- Continuous research studies are required to identify the long term impacts on aquatic ecosystem and their magnitude.

Progress : Financial: 108.15% Physical: 100%

PROJECT NO: 5.5

INVESTIGATION OF CAUSES FOR EMERGENCY INCIDENTS SUCH AS OIL SPILLS, ALGAL BLOOMS AND FISH KILLS, FISHING DISPUTES (EMERGENCY STUDIES)

Objectives:

- To investigate the causes for emergency situations in terms of water pollution, oil spills, fish kill incidents, algal blooms etc.
- Give recommendations to overcome the situation.

Methodology:

Fish mortalities

Numerous incidents of fish mortalities and unexpected changes of natural aquatic environment have been reported yearly due to various reasons. A team of officers visit the place of such incident and carry out investigations. Background information of the incident was obtained through discussions with relevant stakeholders and field observations. In-situ water quality parameters were measured on the spot and water and fish samples were collected for further laboratory tests. Fish tissue analysis, disease/pathogen identification, microbiological tests were performed. Recommendations were provided to relevant stakeholders in order to control the emergency situation and restore the natural condition.

Other emergency studies:

A team of experts visited the place of incident and investigations were carried out. A comprehensive study report was provided to relevant authorities to take necessary steps.

Output

Study reports with recommendations have been provided to relevant stakeholders.

Outcome

Improved knowledge of aquatic habitats and their changes due to different climatic conditions and pollution impacts.

Recommendations

	Incident	Reason	Recommendation/s
Fish Mortality Incidents			
1.	Fish Mortality at Nandikadal Lagoon	Due to lack of Dissolved oxygen	Submitted internal presentation with recommendations
2.	Fish kill incident at Kajugaha Kubura Wawa, Walisara, Ragama	Low dissolved oxygen levels	Reduce accumulation of waste Excessive fish stock should be transferred to suitable place
3	Fish kill at Kala Wewa, Anuradhapura	Overcrowding of *Tilapia niloticus* (Nile Tilapia) Infected by bacterial pathogen	Submitted internal report with recommendations
4	Fish kill incident at Kaudulla Wewa, Polonnaruwa	Overcrowding of Tilapia niloticus (Nile Tilapia) Bacterial infection	Control overcrowding of Tilapia fish by encouraging fishing
5	Fish Mortality at Bandagiriya Wewa, Hambanthota	Overcrowding of fish species	Control overcrowding of fish by encouraging fishing. Sent recommendations to NAQDA
6	Fish kill at Mahadiwul wewa, Trincomalee	Due to lack of water in dry climatic condition	Reasons informed to relevant parties
7	Mahabowewa, Rukmalgama, Kottawa	Due to low oxygen content in water	Reasons informed to relevant parties
Other Studies			
1	Study on Sea Bass Culture potentials in Trincomalee bay	As per the request of Minister of Fisheries	An internal report was submitted
2	Study on aquatic organisms in water way around Sri Dalada Maligawa, Kandy	As per the request of Sri Dalada Maligawa, Kandy	A report was submitted to Sri Dalada Maligawa and Urban Development Authority
3	Water colouration incident in Pitipana, Mahawatta Thotupala, Negombo	Nothing wrong in water quality	Informed to complained party by a letter.






Figure 22 : Photographs of Fish kill Incident

Progress : Financial: 97.92% Physical: 100%

PROJECT NO : 6.3
QUALITY IMPROVEMENTS TO ESD LABORATORY AND TEST & ADVISORY SERVICES

Objective:
Transform the present laboratory into a full-fledged accredited Water quality and environmental laboratory through a series of improvement programmes on step by step basis.

Description:
Monitoring of Water quality is an important tool for pollution control in aquatic environment. This helps in management and conservation of ecological aspects including biological and fisheries aspects. It is very important to have a fully equipped ESD laboratory since NARA is the mandatory institution for Research and Development of aquatic research.

Out Put:
Within the year of 2017, Department premise was expanded with renovated four rooms closer to the laboratory and that was designed as a new office area. New office area and laboratory area was separated by establishing new doors and door frame. Also two laboratory sink were installed with wooden frame cupboard. Certain instrument and portable meters were repaired such as, pH, Atomic Absorption Spectrophotometer, Avon and multimeter.

Consultancies and Test services done by the Division

Consultancies

- Environmental Impact Assessment of Fish Processing/Fish Meal Factory (waste water treatment and other impacts) of Fish Canning and Fish Meal factory, Cool Man Company at Pesalai, Mannar. 2017.
- Initial Environmental Examination (IEE) Report on Proposed (2 Dimensional) Seismic Survey for Petroleum Exploration Covering Deep Sea Blocks (JS-5 & JS-6), North East Offshore, Sri Lanka, December, 2017.

Test Services

- During the period, 47 clients have been provided with test reports by Environmental Studies Division and the total earning is Rs.660, 480.00.
- During this period, Officers participated in several scoping meetings related to EIA and IEE projects conducted by the Central Environmental Authority and the Coast Conservation Department to advise on management and conservation of aquatic resources.

Meetings Attended during the period

1. A meeting to update NOSCOP, held at Board Room, Marine Environment Protection Authority (MEPA), on 23rd February 2017.

2. Meeting on " The 22nd National Wetland Steering Committee" on 18th May 2017 at Saptha Parisara Mandapaya, Ministry of Mahaweli Development and Environment, Sampathpaya, Baththaramulla

3. Meeting on Colombo Port City Development Project on 13th June 2017

4. Meetings on Establishment of Crab City in Hambanthota District-Phase 2 on 4th May 2017 at Central Environmental Authority, Denzil Kobbekaduwa Mawatha ,Baththaramulla.

5. Participation on Awareness Raising Presentation Series for R& D Institution and Universities on 28th June 2017 at National Science and Technology commission.

6. Meeting and field survey on Southwest Coast Development Project – Dedduwa on 16.06.2017 – Organized by Central Environmental Authority.

7. Meeting on research work items and monitoring works undertaken for Colombo Port City Project 13th June 2017 Organized by Ministry of Fisheries & Aquatic Resources Development.
8. Meeting on "Metro Colombo Solid waste management project" at Vanathavillu on 27th June 2017.

9. Review Committee meeting on Climate Change Technology Development & Transfer on 28th June 2017 Organized by Ministry of Mahaweli Development & Environment.

10. Meeting on preparation of Low Carbon Development Strategy (LCDS) of Sri Lanka on 03rd July 2017

11. Meeting on Establishment of Crab City in Hambantota District – Phase 1 on 06th July 2017 Organized by Central Environmental Authority

12. Meeting on Mini hydropower Project MaruKanda 07th July 2017 Organized by Central Environmental Authority

13. Stakeholders Meeting on proposed Apartment Complex on 03rd August 2017 Organized by Coast Conservation and Coastal Resources Management Department

14. Meeting on Cleaning up of lagoon and shallow seas of Negombo on 04th August 2017 organized by Ministry of Megapolis and Western Development

15. Meetings on Introduction of Agreement for the Transfer of biological Resources (Material Transfer Agreement/MTA's) on 25th August 2017.

16. Setting up a National Rapid Emergency Mapping on 30th of August 2017 Organized by Ministry of Disaster Management Centre

17. Meeting on National Thematic Research Programme on Climate change and Natural Disasters "1st Research Coordinating meeting"- At Auditorium of the National Science Foundation , Colombo-07, On 31st August 2017

18. Awareness on project proposal submission and accreditation process to me Green Climate Fund on 08th Sep, 2017 Organized by Ministry of Mahaweli Development & Environment

19. Meeting on Proposed Sinakma Mini-hdropower Project 14th September 2017 Organized by CEA

20. Meeting on National Coastal Resource Projection Week on 15th September 2017 Organized by MEPA

21. Meeting on Metro Colombo Solid Waste Management Project on 19th September 2017 Organized by CEA

22. Meeting on Proposed operation and Construction of the Factory Yard at Ussangoda National park on 19th September 2017, organized by Department of Wildlife.

23. Mettings on Integrated development of selected lagoon on 19th September 2017,Randora Auditorium,Ground Floor, Ministry of Finance and Mass Media
24. Meeting on the construction of a waste water disposal infrastructure at Kattankudy on 21st September 2017 organized by Central Environmental Authority.
25. Development of policy, Strategies and National Action plan for MEPA on 26th September 2017 Organized by MEPA.

26. Discussion on revisiting the EIA process in Sri Lanka on 27th September 2017.

27. Meeting on Land Health is National Wealth on 11th October 2017 organized by Ministry of Lands & Parliamentary Reforms.

28. Meeting on Coastal line cleanup programme from Mattakkuliya to Moratuwa on 17th October 2017 organized by Coast Conservation & Coastal Resource Management Department.

29. Meeting on Mini hydropower Project - Madapitiya on 13th October 2017 Organized by CEA.

30. Meeting on Mini hydropower Project - Digalahinna on 13th October 2017 Organized by CEA.

31. Meeting on Proposed Seethawaka Ganga Hydro power project on 19th October 2017 Organized by Central Environmental Authority.

32. Meeting on Coast Conservation & Coastal Resource Management Advisory Council on 20th October 2017 organized by Coast Conservation & Coastal Resource Management Department.

33. Meeting on Mineral sand in Kinna Muthur on 23rd October 2017 organized by Coast conservation & Coastal Resource.

34. Meeting on Proposed Extension of pipe Borne Sewerage Coverage for Dehiwala-Mt.Laviniya Municipal Council Area on 23rd October, 2017 Organized by Central Environmental Authority.

35. Meeting on monthly coastal line cleanup programme from Mattakkuliya to Moratuwa on 28th October 2017 organized by Coast Conservation & Coastal Resource Management Department.

36. Meetings on Environmental Clearance for Proposed Wastewater Collection and Disposal System for Puttalam Town Area 26th October 2017 Organized by Ministry of Megapolis and Western Development.

37. Meetings on Environmental Clearance for Proposed Wastewater Collection and Disposal System for Chilaw Town Area 26th October 2017 Organized by Ministry of Megapolis and Western Development.

38. Forum Discussion on Empowering Woman for Environment conservation on 26th October 2017 organized by National Committee.

39. Discussion on Updating Marine Conservation & Management Action Plan on 26th October 2017 organized by Department of wildlife Conservation.
40. Meeting on Fishery Harbour at Wellamankara, Wennappuwa on 30th October 2017 organized by Department of Coast Conservation & Coastal Resource Management Department.

41. BIOFIN Working group meeting on 30th October 2017 and 06th November 2017 Organized by Ministry of Mahaweli Development & Environment.

42. Meeting on National Oil Spill Combat Drill 2017 on 31st October, 2017 Organized by MEPA.

43. Meeting on Climate change on 02nd November 2017 organized by Department of Meteorology.

44. Meeting on final report discussion on Environmental Impact Asssessment (EIA) for the proposed extension of pipe borne sewage coverage for Dehiwala - Mt Lavinia Muncipal council area. Central

Environmental Authority on 10th November 2017 organized by Central Environmental Authority, Battaramulla.

45. Meeting on Celebration of World Fisheries Day 13th November 2017 organized by Ministry of Fisheries & Aquatic Resources Development.

46. Meeting on "Development of Dalada Maligawa, Kandy" - Organized by Ministry of Megapolis and Western Development on 16th November 2017.

47. Meeting on Presenting the Focalized Marine Management Action Plan on 16th November 2017 organized by Department of Wildlife Conservation.

48. Meeting on Proposed cross Country Pipeline project (Colombo Port to Kolonnawa Oil Installation 26th November 2017 organized by CEA.

49. Meeting on Stakeholder meeting for the Ambient Water Quality standards and the Categorization of the Kelani River Basin on 8th December 2017 Organized by CEA.

50. Meeting on National Oil & Spill on 14th – 15th December 2017 organized by MEPA.

51. Meeting on Coast Conservation & Coastal Resource Management & to increase the monthly mine quantity of mineral sand with value addition system in Kinniva on 14th December 2017 organized by CCD.

Workshops

1. XVth Monsoon Forum organized by the Department of Meteorology (DOM) on 04th May 2017
   N.D. Hettige

2. Workshop on procurement processes on 16-18 June and 23 -24 June 2017 –organized by Ministry of Fisheries and Aquatic Resources Development.
   Dr. W.D.N. Wickramarachchi

3. XVIth Monsoon Forum organized by the Department of Meteorology (DOM) on 20th June 2017 N.D.Hettige.

4. Workshop on "Future of Colombo Wetlands on 27th June at Biodiversity park, Thalawathugoda.
   Dr. W.D.N. Wickramarachchi
5. Workshop on a Drafting a national policy for the use of oil dispersant in Sri Lanka organized by Marine Environment Protection Authority on 30th June 2017.
   N.D. Hettige and M.D.S.R. Maddumage

6. Workshop on "To update National Oil Spill Contingency Plan (NOSCOP) organized by Marine Environment Protection Authority on 14th July 2017
   .N.D. Hettige and J.K.P.C. Jayawardhane

7. Annual 04 Days National Workshop for Capacity Building in First Respondents of Oil Spill, at Sri Lanka Foundation on 15th - 18th August 2017 organized by MEPA.
   J.K.P.C. Jayawardhane

8. Workshop on National Thematic Programme on Climate Change and Natural Disasters: Organized By National Science Foundation (NSF) On 31st August 2017.
   N.D. Hettige

9. Workshop on awareness on proposal submission and accreditation process to the Green Climate Fund (GCF)-Organized by Mahaweli Development and Environment On 08th September 2017.
   Dr. A.A.D. Amarathunga and N.D.Hettige

10. Workshop on development of policy strategies and National Action plan for Marine Environment Protection in Sri Lanka on 26th
    Dr. W.D.N. Wickramarachchi

11. Workshop on Negombo Lagoon Management on October 2017 Organized by Marine Environmental Protection Authority.
    N.D. Hettige and B.R.C. Mendis

12. Capacity Building Programme on Green House Gas Inventory Preparation and Other Component of Sri Lanka's Third National Communication on Climate Change, held at Centre for Banking Studies, Rajagiriya on 12th – 15th December 2017.
    J.K.P.C. Jayaward hane

13. Workshop on Awareness Programme Environmental Examination report Regulations to be published by MEPA 20th November 2017.
    A.A.D. Amaratunga

14. Workshop on Proposal writing 21st December 2017 at SLCARP Secretariat.
    S.R.C.N.K. Narangoda

Reports

1. Study on identification of sea bass aquaculture potentials sites for Seabass culture Tricomalee Bay
   N.D.Hettige, J.K.P.C. Jayawardhane, K.P.G.L. Sadaruwan, J.S. Jayanatha, L.S.C.Siriwardena

2. Study on water quality and aquatic organisms in the moat in front of Dalada Maligawa, Kandy
   R.R.A.R. Shirantha, N.D. Hettige and M.D.S.R. Maddumage
3. Preliminary Report on Fish kill Investigation of Kala Wewa
   M.D.S.R. Maddumage, S.R.C.N.K. Narangoda, K.A.W.S. Weerasekara, W.D.N. Wickramarachchi, N.D. Hettige

Posters

1. Weerasekara, K.A.W.S., Hettige, N.D., Azmy, S.A.M., Priyadarshani, J.P.M.L. and Jayawardene, J.M.C.K., 2017. Evaluation of the status of water pollution at Beruwala, Hikkaduwa and Tangalle Fishery Harbours, Sri Lanka,3rd National Symposium on Marine Environment, Marine Environmental Protection Authority, pp.43.

Local Training

1. 41st Certificate course in Arc GIS, Department of Geography, University of Colombo, 24th March-31st May 2017 .
   S.R.C.N.K. Narangoda & M.D.S.R. Maddumage

Foreign Training/ /Discussion

1. Seminar on ICM promoting comprehensive economic strength of maritime cities for developing countries from 22nd October to 11th November in Xiamen, People Republic of China.
   J.K.P.C. Jayawardhane

2. Bilateral talk on "Marine research of EEZ of Sri Lanka", Third Institute of Oceanography, State of ocean administration,Xiamen from 5th November to 11th November 2017.
   Dr. W.D.N.Wickramarachchi

Publications

International Abstracts

1. Amarathunga, A.A.D., and Kazama, F, (2017). Impact of farmer's perceptions, and landuse pattern to pesticide loading from upper catena of the tropical river basin (Upper Kotmale Basin) in Sri Lanka. Asian journal of water, environment and pollution. Vol. 14, No 4 (2017), pp43-59. DOI 10.3233/AJW-170036.
2. Samarakoon, S.A.D.M., Hettige, N.D., Amarathunga, A.A.D., Jayasinghe, G.Y.2017. Assessment of Pollution Risk in Maduganga Lagoon with Special Reference to Water Quality and Benthos, International Symposium on Agriculture and Environment, pp.

Local Abstracts

1. Weerasekara, K.A.W.S., Pathiratne, A. and Kithsiri, H.M.P. 2017. Prevalence of CKDu in Medawachchiya area with special reference to the physical characteristics and source of drinking water NARA Scientific Sessions, p.46.

2. Weerasekara, K.A.W.S., Hettige, N.D., Azmy, S.A.M., Priyadarshani, J.P.M.L. and Jayawardene, J.M.C.K., 2017. Evaluation of the status of water pollution at Beruwala, Hikkaduwa and Tangalle Fishery Harbours, Sri Lanka,3rd National Symposium on Marine Environment, Marine Environmental Protection Authority, pp.43.
3. Amarathunga, A.A.D., Dahanayake,D.D.G.L., Azmy, S.A.M., Pahalawattarachchi, V. and Hettige, N.D., 2017.Assessment of Environmental damage due to oil spill incident at Lunawa Lagoon, Muthurajawela, Sri Lanka, 3rd National Symposium on Marine Environment, Marine Environmental Protection Authority, pp.17.

4. Hettige, N.D., Amarathunga, A.A.D., Narangoda, S.R.C.N.K., Madduamge, M.D.S.R. and Weerasekara, K.A.W.S., 2017. Assessment of Current Status of Water Quality in Madu Ganga Lagoon: A Ramsar Wetland in Sri Lanka, NARA Scientific Sessions, pp.

5. Mendis, B.R.C. Najim, M.M.M, Kithsiri, H.M.P and S.A.M Azmy (2017). Heavy metal pollution in water and their effect on *Mugil cephalus* fish tissues at Negombo estuary. "Aquatic Research for Blue Economic Development, NARA, Scientific Sessions - 2017, Colombo, Sri Lanka, pp.

6. Mendis, B.R.C. Najim, M.M.M and Kithsiri, H.M.P (2017). Heavy Metal Levels in Selected Mud Crabs (*Scylla serrata*) Muscle Tissues From Negombo Estuary. In: Annual Research Symposium - 2017, Faculty of Graduate Studies, University of Colombo, Sri Lanka.pp.

7. G.M.T.E. Jayaratne, G.J. Ganegama Arachchi, ***A.A.D. Amarathunga***, Ruchitha Perera and Wickramasinghe, 2017. Investigation of histamine in *Katsuwonu spelamis* (skipjack tuna) harvested by multi-day boats using a rapid colourimetric method. Proceedings of the National Aquatic Resources Research and Development Agency (NARA), Scientific Sessions. Colombo, Sri Lanka.pp58.

8. N.D. Hettige, ***A.A.D. Amarathunga***, S.R.C.N.K. Narangoda, M.D.S.R. Madduamge and K.A.W.S. Weerasekara, 2017. Assessment of current status of water quality in Madu Ganga Lagoon: A Ramsar Wetland in Sri Lanka. Proceedings of the National Aquatic Resources Research and Development Agency (NARA), Scientific Sessions. Colombo, Sri Lanka.pp43.

9. K.C.S. De Silva, ***A. A. D. Amarathunga*** and S. C. Jayamanne, 2017. Study on diazinon pesticide adsorption to soil and its impact on two species of zooplankton. Proceedings of the National Aquatic Resources Research and Development Agency (NARA), Scientific Sessions. Colombo, Sri Lanka. pp33.

Supervisor - Industrial Training Students

1. Two student from University of Sri Jayawardenepura, Sri Lanka under the B.Sc.in Forestry and Environmental Science (Industrial Training Basis)

2. One student from University of Kelaniya, Sri Lanka under the B.Sc.in Environmental Management

3. Four student from Uvawellassa University of Sri Lanka under the Aquatic Resource Management (Industrial Training Basis) - One week

Special Events – Colombo Sea Food Festival, 8-10 December, 2017 at Green Path Colombo 07

Environmental Studies Division has contributed to seafood festival for following events:

1. Water quality testing demonstration

Water quality monitoring can help researchers to predict and learn from natural processes in the environment and determine human impact on an ecosystem. Demonstration on water quality Parameters such as pH, Dissolved Oxygen, Conductivity, Salinity and Turbidity were conducted in the festival premises using portable meters and how to carry out the testing was described by division members to participants.



Figure 23: Demonstration on Water quality parameters

2. Art Competition

The Art Competition was conducted for school children under three age categories parallel to the Colombo seafood festival that was much appreciated and encourages children creativity. Total of 120 students were participated for the competition within two days. A theme of the completion is based on the blue economic concepts. The Pentium 2000 stationeries (pvt) Ltd sponsored for painting accessories and other stationeries. Senior Lecturers of University of visual and performing Art had participated as the judges for competition. The top three in each category has awarded with medals (Gold, Silver and Bronze) presents and all participants were appreciated with certificates.









Figure 24: Art Competition

3. Leaflets preparation

Topics

1. "Marine Protected Areas in Sri Lanka: Smart Investment in ocean health"

2. "Environmental studies Division "(National Aquatic Resources Research and Development Agency)

3. "Emergency Incident: causes ad prevention"

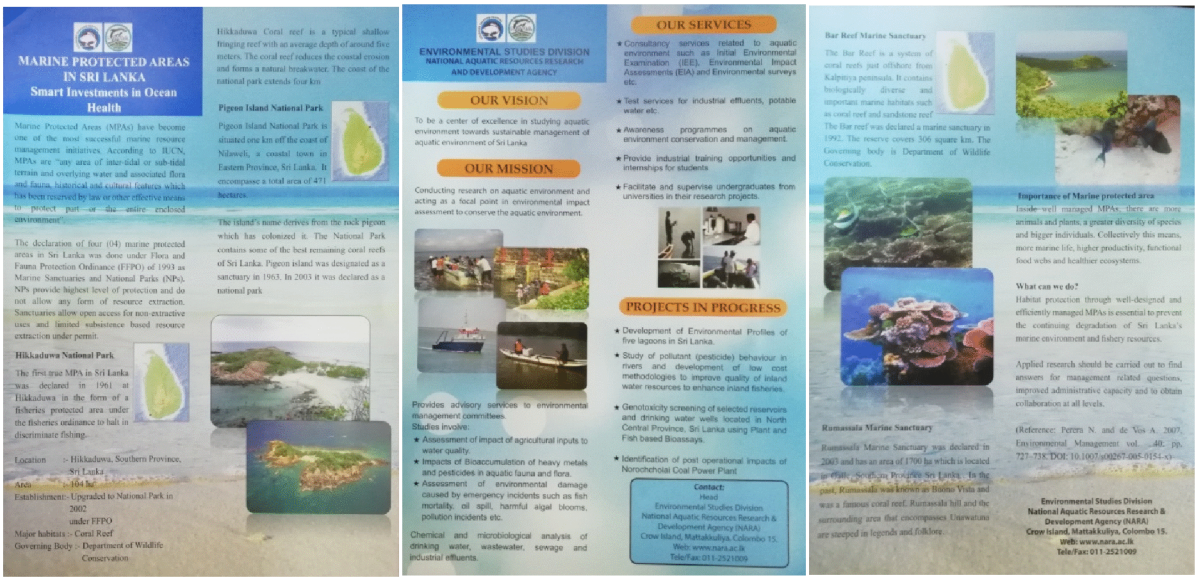


Figure 25: Leaflets

4. Posters preparation

Topics

1. Benthic Macro invertebrates

2. Land based and Sea based activities causing Marine Pollution

3. Water Quality Testing

4. Water Pollution

5. Sri Lanka towards, A Blue Economy









Figure 26: Posters

FISHING TECHNOLOGY DIVISION







5.2 FISHING TECHNOLOGY DIVISION

Head of the Division : N.B.P.Punyadewa

Fishing Gear Technology division is conducting development project regarding fishing gears and methods used in Sri Lanka. To Enhance the wellbeing of fisherman and to enhance the fish production of the country are the major objective by conducting these development projects. Therefore during year 2017 following two projects were conducted.

1. Deployment of Fish Aggregating Devices (FADs), Floating Buoy and Fish Enhancing Devices (Submerge FEDs) to enhance the fish production in coastal water (Project No 1.4)

2. Habitat enhancement for "Big Fin Reef Squid's spawners" (*Sepioteuthis lessoniana*) at their own breeding ground and culturing of Squids at captive condition (Laboratory Scale Culture Studies) (Project No2.1)

Activities

Deployment of low cost Fishing Aggregating Devices and Fish Enhancing Devices are popular fishing technique in many countries of the Asian region. Even in Sri Lanka these low cost FADs and FEDs are used quite successfully in the western and southern areas and sea. These as having good potential whereby the small scale fishers in the other parts of the country can earn good incomes. Therefore, under the project number 1.4, In order to the request of fisherman in Sinnapaduwa area, 20 submerged Fish Enhancing Devices (FEDs) were deployed in selected location about 6km away from the shoreline at the with community participation. Submerged FEDs are safer than floating FADs because its encounter less hazardous from fishing boats, fishing gears and other natural disasters. Reinforce concrete anchors were used for fixed the and hold the feds in a certain location. Spear shaped structures were deployed as FEDs which were made from iron bars and covered with nylon nets. Reinforcing the anchor will strengthen the concrete against cracking which were caused by the impacts during deployment and while in use. Strong floats were used to support the weight of structure and to make the anchor line into vertical position. A mixture of polythene form A and polythene form B filled galloons were used as floats. Data collection process was started after the deployment. For that purpose data recording books were distributed among fisherman to keep recording. As soon as the deployment, underwater observation was started and video recording was done. Total three underwater observation sessions were conducted. As well as catch data were collected. Around the subsurface FEDs *Lutjanus fulviflamma ,Ciganusspp, Plectorhinchus spp,* Rainbow runners, Leather jacket, Squids, mackerel scads and other small fish species were the recorded.

Under the project no 2.1, Habitat enhancement for "Big Fin Reef Squid's spawners" (*Sepioteuthis lessoniana*) at their own breeding ground and culturing of Squids at captive condition (Laboratory Scale Culture Studies) project was conducted during year 2017, in Sinnapaduwa fishing area with community participation. Currently marine habitats of the Sri Lanka coastal area are depleting due to human and natural events. Some of fisherman use destructive fishing methods to catch more fish, waste oil from fishing boats, ocean acidification, changes of ocean currents are the kind of reasons to deplete the marine habitat and marine fish stock around Sri Lanka. Therefore fish and other marine organisms have lost them habitat for the reproduction, rearing juveniles and feeding. Thus fish stock is reducing and fish tend to migrate away from coastal area of Sri Lanka. Big Fin reef squids (***Sepioteuthis lessoniana)*** are an economically valuable species and underutilized resource. It has high economic value in the export market.

As well as it is a good aquarium organism for marine aquarium. Due to the habitat destruction squids have lost places for spawning process. Sometime squids laying them eggs even on the fishing net. They have lost substrate and protective environment to egg laying process. By conducting this project we enhance the marine habitat for all of marine organisms while providing substrate to the squids egg laying process. Other countries are doing culturing of squids at the land base aquarium. Eg. Thailand. Parallel to the field work laboratory culturing program is conducting to grow out squids in the marine water ponds. For enhance marine habitat and support to the spawning process of the big fin reef squids "Sepioteuthis *lessoniana"*, three types of structures were developed and deployed at selected area in Sinnapaduwa with participation of fisherman. During the project period artificial structures were deployed at 11m (36 feet) depth, under the calm sea condition. 12 units of each structures were deployed before monsoon period. Data of squid's egg attachment data werecollected and number and type of attached squid's eggs were recorded. At the same time aggregated fish species around the structures were monitored. Out of three models, two models were performed well (type 02 and type 03). Large number of egg attachment were observed on conical shape iron structures. Project work were interrupted by the South West Monsoon (May to September).Squid's eggs were collected and cultured in the aquarium in NARA. Squids eggs were hatched under the laboratory condition and offspring were reared in glass tanks. Water quality conditions were monitored, Structures which used to habitat enhancement process are successful and it is enhance the fish stock in install sea area. Large number of fish species and squids use these structures as house. Therefore, more structures need to be deployed around the coastal area of Sri Lanka at the selected locations to enhance the fish stock by enhancing the marine habitat.

As well as these structures provide substrate to squids egg laying process. It will enhance the squid population.

Programme	Project	Allocation Rs (Million)	Officers responsible	Period from	Physical Progress	Financial Progress
Development of New Fishing Techniques	Deployment of Fish Aggregating Devices (FADs), Floating Buoy and Fish Enhancing Devices (Submerge FEDs) to enhance the fish production in coastal water (Project No 1.4)		NBP Punyadeva	2017 Jan-Dec	T-100% P- 95%	T- 100 % P- 124 %
	Habitat enhancement for "Big Fin Reef Squid's spawners" (*Sepioteuthis lessoniana*) at their own breeding ground and culturing of Squids at captive condition (Laboratory Scale Culture Studies) (Project No2.1)		NBP Punyadeva	2017 Jan-Dec	T-100% P- 90%	T- 100 % P- 94 %

TRAINING / AWARENESS PROGRAMMES CONDUCTED

Meetings were conducted with, Fisheries Inspectors and fishermen of in the fishing area.

CONSTRAIN

Most field visits were cancelled due to lack of vehicles and due to bad sea conditions.

PROJECT NO : 1.4

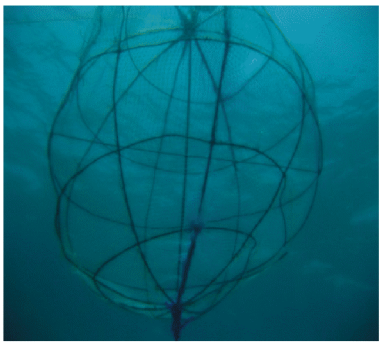
DEPLOYMENT OF FISH AGGREGATING DEVICES (FADS), FLOATING BUOY AND FISH ENHANCING DEVICES (SUBMERGE FEDS) TO ENHANCE THE FISH PRODUCTION IN COASTAL WATER

Images for project no 1.4

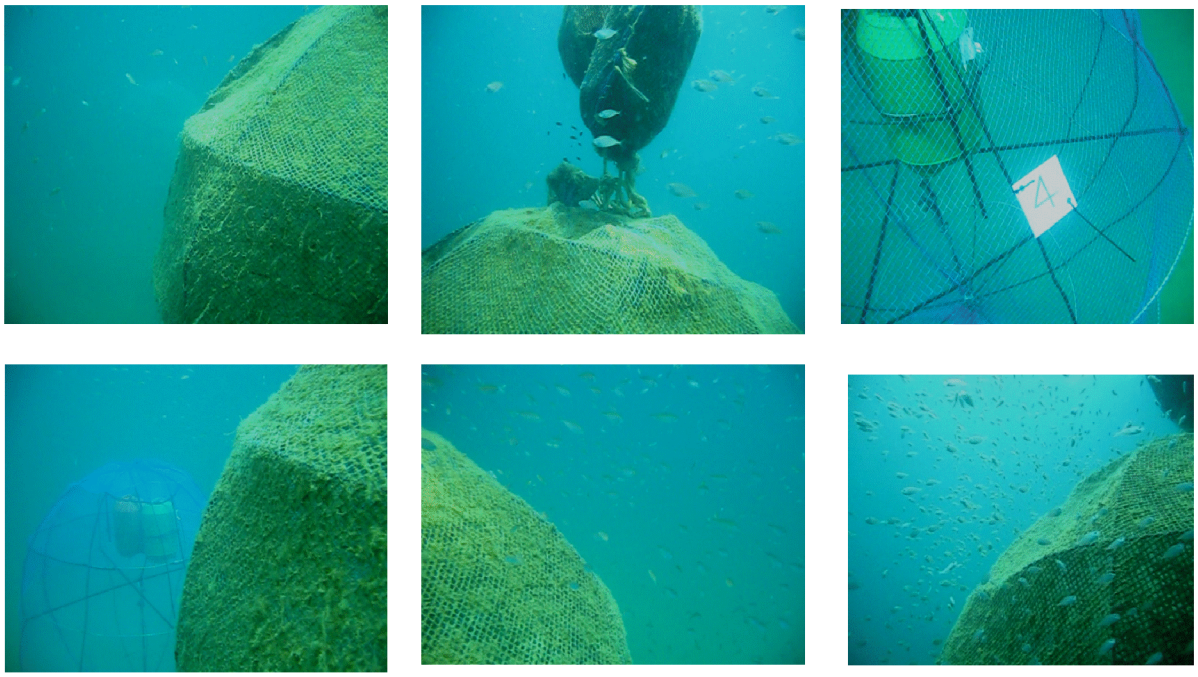












Following three types of Structures were constructed and deployed before southwest monsoon on Sinnapaduwa sea area.



Structure Type 01
(Concrete Slab+ Bunch of rope)



Structure Type 02
(Concrete Slab+ Plastic barrel)



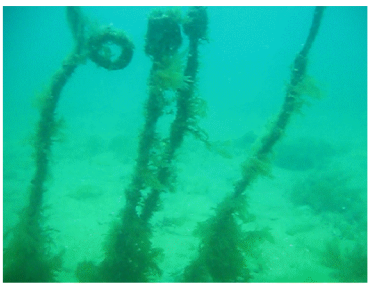
Structure Type 03
(Conical shape iron bar structure)



Before Installation



Just after installation



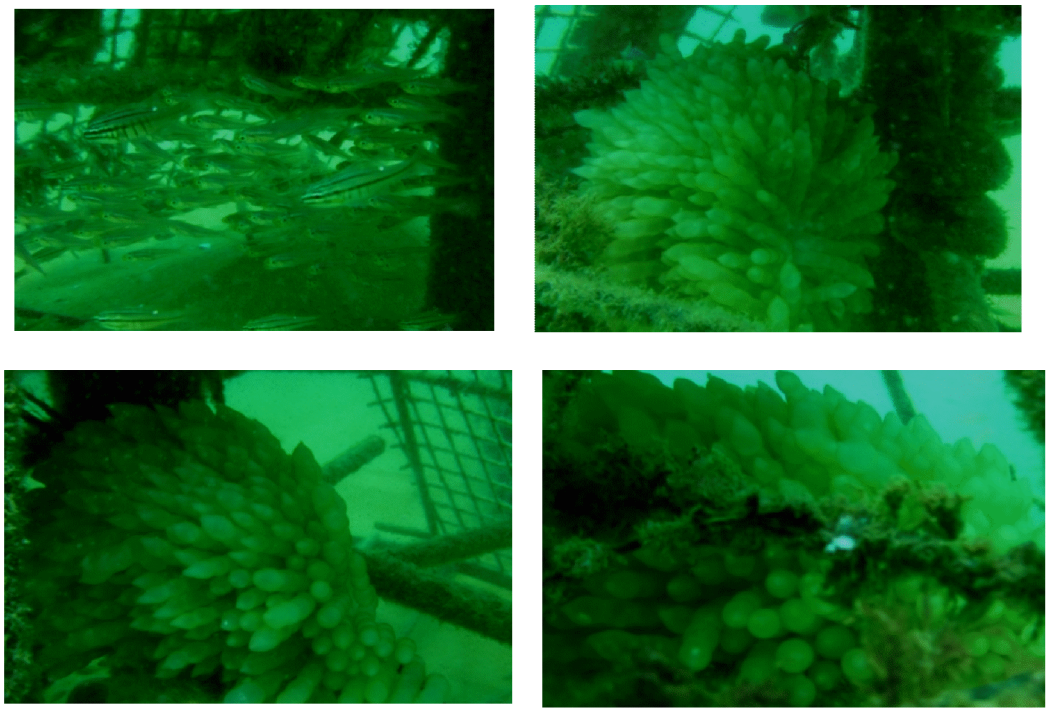
One Month later







Construction and deployment of type 03 structures



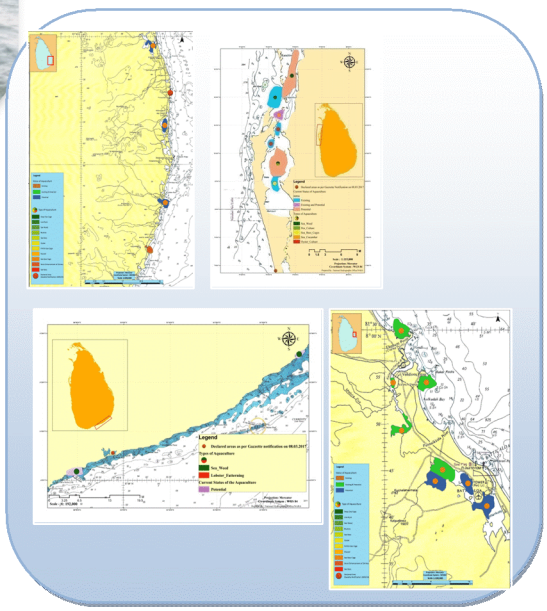
Fish and squids eggs on type 03 structures

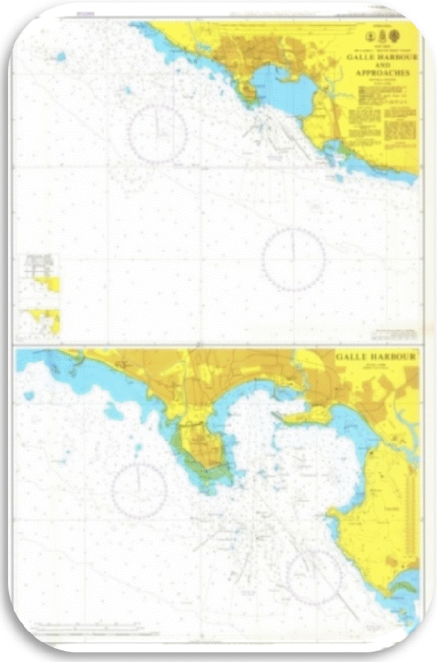


Culturing of squids eggs at the marine aquarium of NARA

NATIONAL HYDROGRAPHIC OFFICE







5.3 NATIONAL HYDROGRAPHIC OFFICE

Head of the Division : Mr. A.N.D. Perera

Overview of the Year

The prime objective of National Hydrographic Office (NHO) is to provide Hydrographic services to ensure safe and efficient navigation in Sri Lankan waters. This is a mandatory requirement of full filling the obligation of the International Convention for the Safety of Life at Sea (SOLAS). Accordingly charting areas are selected to ensure that hydrographic surveys are being carried out, as far as possible, adequate to the requirements of safe navigation where stakeholders are requested to prioritize. The other principal services are the provision of up dated and accurate topographic and bathymetric data for coastal zone management, environmental protection and maritime delimitation. The up to date hydrographic information coverage offers significant economic and commercial benefits through facilitating maritime trade and other marine activities.

It has been realized hydrographic data is underpinning the blue economy activities accordingly NHO carried out new surveys for five lagoons to prepare lagoon profiles. Hydrographic information form a vital an valuable part to calculate carrying capacity to quantify the full economic and commercial benefit of each proposed projects of developing lagoons. In this regards environment monitoring surveys will also be continuing for Port City Development Project.

Contribution to National Ocean Affairs Committee (NOAC), Sri Lanka has submitted the claim for delineation of continental margin in 2009 to United Nation Convention on Law Of the Sea (UNCLOS), currently sub commission is considering the Sri Lankan claim and NHO is contributed to carry out new surveys and data analysis works for (NOAC) to verify the request made by sub commission.

For the year 2017, the following surveys and activities were conducted.

1.0 National Charting Program

1.1 Nautical Chart of Approaches to Kankesanturai

1.2 Bathymetric Data Acquisition for Coastal Chart Trincomalee to Point Pedro

1.3 Bathymetric data acquisition for Coastal Chart Weligama to Colombo.

1.4 Nautical Chart of Kalpitiya Lagoon

1.5 Upgrading the published charts

2.0 Lagoon Surveys

3.0 Surveys conducted for special requests

4.0 Contribution to Other Projects

Activities Undertaken

Program/Projects	No.	Activities	Officer Responsible	Period
1.0 National Charting Programme	1.1 1.2 1.3 1.4 1.5 1.6 1.7	Data Acquisition for Nautical Chart of Approaches to Kankesanturai Data Acquisition for Coastal Chart Trincomalee to Point Pedro Data Acquisition for Coastal Chart Weligama to Colombo equivalent to BA Coastal Chart 3700 Nautical Chart of Kalpitiya Lagoon Upgrading the published Nautical Charts Data processing and Cartography Compilation of available data layers to produce proposed ocean based tourist map	S.R.C. Ranaweera C.K. Amarasinghe Y.M.R.N. Kumari R.K.A. Ariyarathne K.A. Ranasinghe D.L.P. Hewage L.S.C. Siriwardane R.M.D.I. Rathnayake W.A.A.P. Wijesundara S.R.T.B. Singhabahu B.H.B. Jayamalie	Jan- Dec
2.0 Lagoon Surveys	2.1	Bathymetry with physical carrying capacity in; Kokilai Lagoon Panama Lagoon Rekawa Lagoon Negombo Lagoon Puttalam Lagoon	S.R.C. Ranaweera C.K. Amarasinghe Y.M.R.N. Kumari R.K.A Ariyarathne K.A. Ranasinghe D.L.P. Hewage L.S.C. Siriwardane R.M.D.I. Rathnayake W.A.A.P. Wijesundara S.R.T.P. Singahabahu B.H.B. Jayamalie	Jan- Dec

3.0 Surveys Conducted for Special Requests from Government and other Institutions	3.1 3.2 3.3	Bathymetric Survey for Walkers Colombo Shipyard (Pvt) Ltd Beach Profile and Bathymetric Survey of Colombo Port City Development Project Bathymetric survey at Gangewadiya for Ceylon Fishery Harbour Corporation	S.R.C. Ranaweera C.K. Amarasinghe Y.M.R.N. Kumari R.K.A Ariyarathne K.A. Ranasinghe D.L.P. Hewage L.S.C. Siriwardane R.M.D.I. Rathnayake W.A.A.P. Wijesundara S.R.T.P. Singahabahu B.H.B. Jayamalie	 Jan- Dec
4.0 Contribution to Other Projects	4.1 4.2 4.3	Assistance to NOAC (National Ocean Affairs Committee) to deal with Delimitation of the outer edge of the continental margin of Sri Lanka. Mapping for Potential sites for Aquaculture - NARA/NAQDA Wildlife joint project Contribution of Petroleum Resources Development Secretariat (PRDS)	S.R.C. Ranaweera C.K. Amarasinghe Y.M.R.N. Kumari R.K.A Ariyarathne K.A. Ranasinghe D.L.P. Hewage L.S.C. Siriwardane R.M.D.I. Rathnayake W.A.A.P. Wijesundara S.R.T.P. Singahabahu B.H.B. Jayamalie	Jan-Dec

PROJECT NO : 1.1

DATA ACQUISITION FOR NAUTICAL CHART OF APPROACHES TO KANKESANTURAI

The Kankesanturai harbor is to be developed as the third international harbor after Colombo and Ruhunu Magampura. Therefore, the nautical chart of this area is a prime requirement to fulfill the obligations to ensure safe access to this harbor. Kankesanturai is the main port situated in Jaffna District Northern Province of Sri Lanka and it is the nearest port for all eastern ports in India as well as for Myanmar and Bangladesh. Rapid development was started in war affected areas by government to uplift the living conditions of the civilians. Under this project provides hydrographic data to facilitate development of coastal passenger transport and fishing activities.

As planned in the NHO action plan of the year 2017 and according to the Memorandum of Understanding between National Hydrographic office of NARA and SL Navy, both parties were involved for the bathymetric data acquisition to produce Approaches to KKS chart. The data collection is 100 % completed.

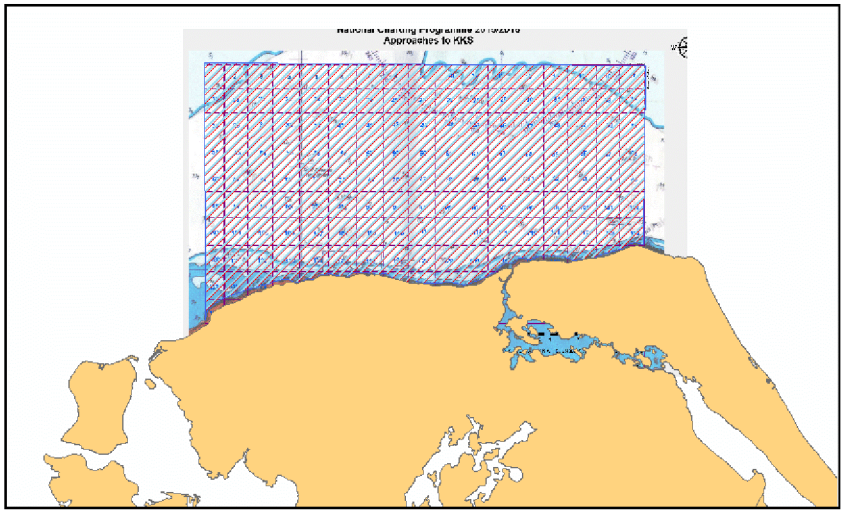


Figure 1.1- Approaches to Kankesanturai Chart



Figure 1.2 - Field Works at Kankesanturai

PROJECT NO : 1.2
DATA ACQUISITION FOR COASTAL CHART TRINCOMALEE TO POINT PEDRO.

This is the first phase of hydrographic surveys for production of initial bathymetric sheets intending to compilation of the Coastal Chart Trincomalee to Kudremalai point. Total sea area intended to cover from this chart is 21,410 km^2.

The physical progress of the year is 30% and the total surveyed area is 6,425 km^2. The main constrain was the unavailability of RV Sammudrika for nine months period of the year due to the repairing works.

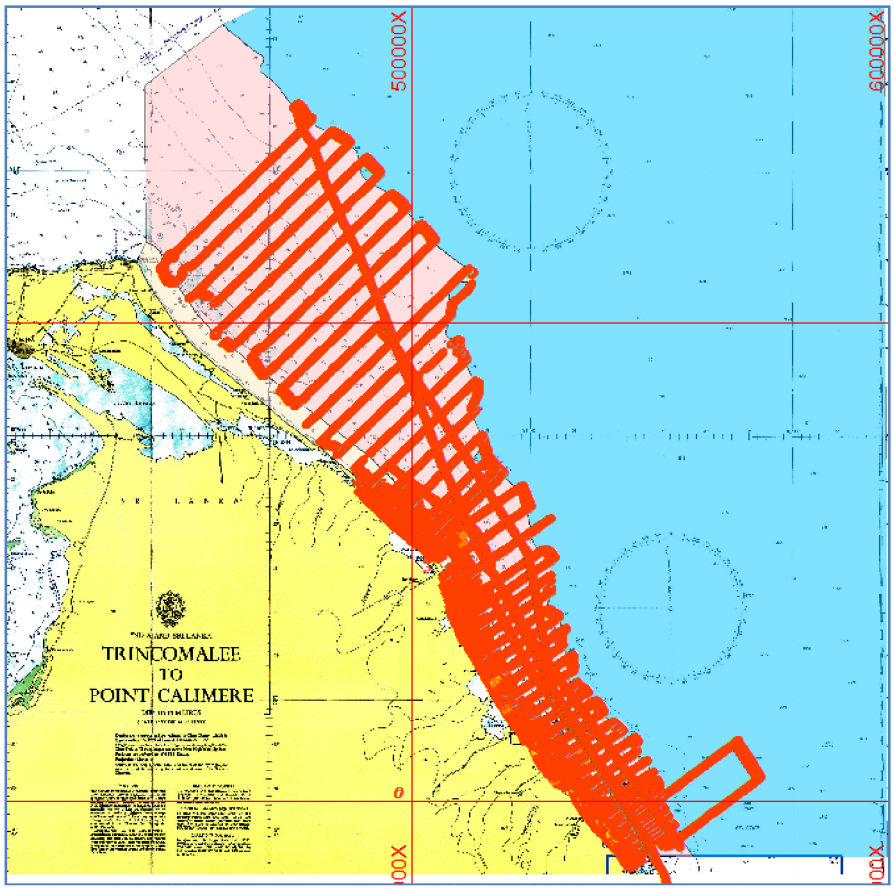


Figure 1. 3- Area coverage on Coastal Chart Trincomalee to Point Pedro



Figure 1.4 - Field works at Pulmudai

PROJECT NO : 1.3

BATHYMETRIC DATA ACQUISITION FOR COASTAL CHART WELIGAMA TO COLOMBO

The data acquisition for Coastal Chart Weligama to Colombo was conducted under National Charting Program using RV Samuddrika. The progress of the data acquisition and processing is 70% (1610 km^2) of the total planned area of 2300 km^2 of the year 2016. Although, the rest of the surveys 6282 km^2 were planned where in deep sea areas using R.V. Sammudrika couldn't complete due to unavailability of the vessel as major repair works and modification of vessel for Norway Project during 2017.

Further, the planned near shore areas were 900 km^2 using "Bar Reef" small boat and could be covered 410 km^2 due to bad weather prevail. The physical progress is 46% from the total targeted near shore area for the year 2017.

The overall progress of the coastal chart Colombo to Weligama is 60%.

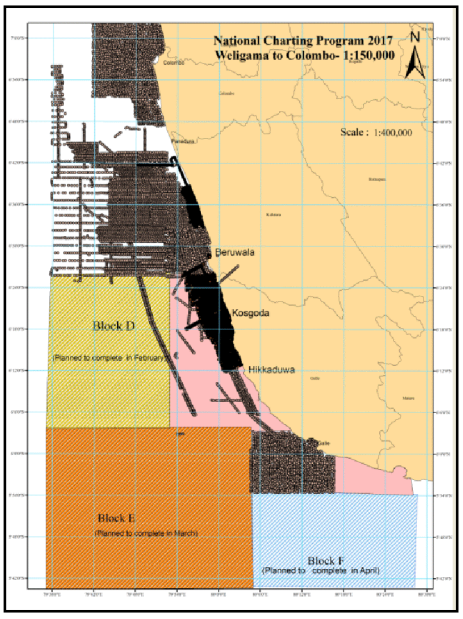


Figure 1.5 - Offshore Data- Coastal Chart Weligama to Colombo

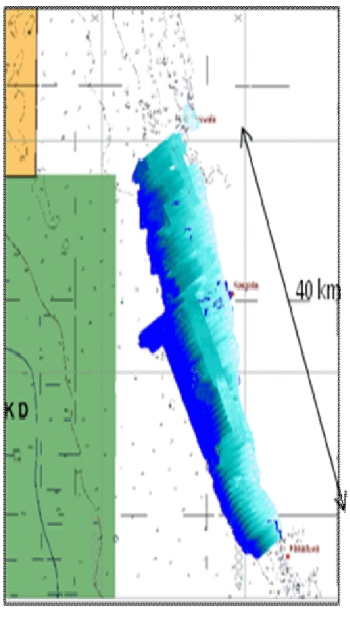


Figure 1.6 - Near shore Data- Coastal Chart Weligama to Colombo

PROJECT NO : 1.4

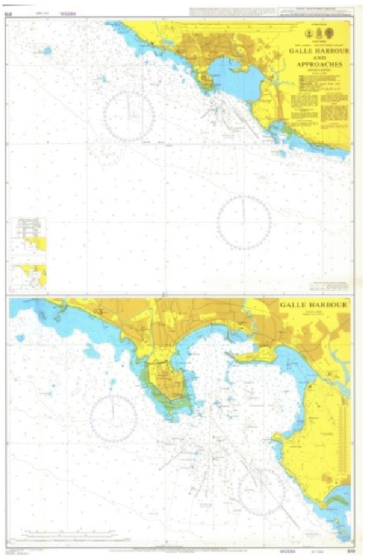
NAUTICAL CHART OF KALPITIYA LAGOON

Due to special request priority is given to "Proposed fishery harbors & Anchorage sites survey in Northern province" and data analyzing of the five lagoons of Kokilai, Rekawa, Negombo, Puttalam and Panama where necessary resources manpower and equipment allocated. Also surveys planed during the months of September to December are affected by unfavorable weather at sea for the small boat operation. Therefore the progress is 60 km^2.

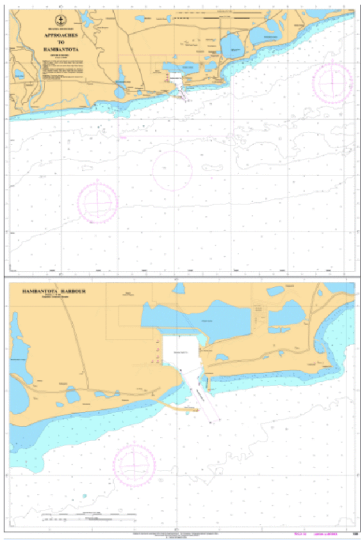
PROJECT NO : 1.5

UPGRADING THE PUBLISHED NAUTICAL CHARTS

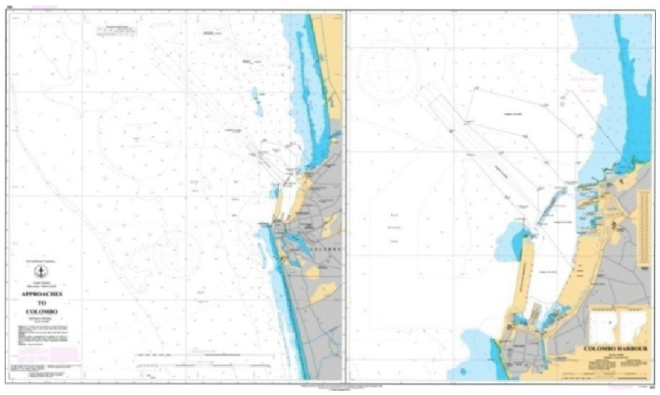
The published charts should be maintained to ensure any changes of bathymetry are applied timely. The upgrading of Approaches to Hambanthota nautical chart is completed in 2017. Further, based on the field visits and consulting Harbor Masters, NHO has identified that no upgrade is required to safe navigation for both Colombo and Galle Harbour nautical charts.



Approaches to Galle



Approaches to Hambantota



Approaches to Colombo

Figure 1.7 – Upgraded Nautical Charts

PROJECT NO : 1.6

DATA PROCESSING AND CARTOGRAPHY

- Data processing for the acquired bathymetry for the Approaches to KKS chart data is completed.
- Data Processing for the acquired bathymetry for the first stage from Trincomalee to Point Pedro in Coastal Chart Trincomalee to Kudiramalei Point is completed.
- Data Processing for the acquired bathymetry for Coastal Chart Weligama to Colombo is completed.

PROJECT NO : 1.7

COMPILATION THE AVAILABLE INFORMATION TO PREPARE THE TOURIST MAP

The tourist map has compiled by integrating all tourists attracted marine information such as ship wrecks, diving locations, yachting facilities, whale watching, coral reefs, light houses, surfing grounds, fishing grounds, commercial harbors, fishery harbors and anchorages, buoys, beacons and depth contours.

PROJECT NO : 2.0

LAGOON SURVEYS

Lagoons are common coastal feature around many parts of the country and support an important subsistence fishery, providing livelihoods to over thousand families. Inland capture fisheries are an important sector of many local economies and are considered to be important in sustaining the livelihoods of many rural communities. They are also important sources of domestic fish consumption and its significance in providing food security and generating local income.

Under this project, five lagoons were surveyed for prepare lagoon environmental profiles.

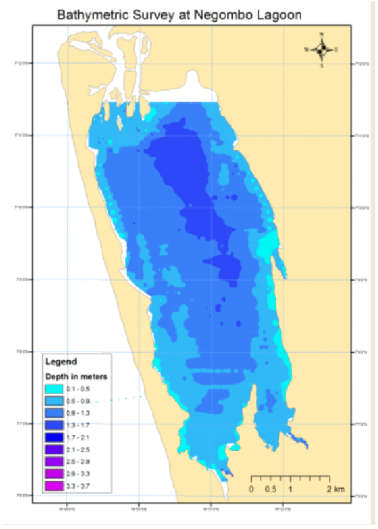


Fig.2.1 - Negombo Lagoon

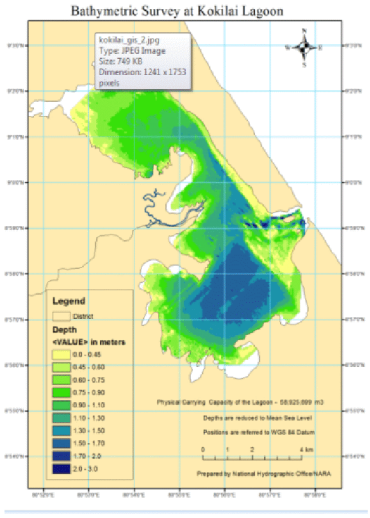


Fig. 2.2- Kokilai Lagoon

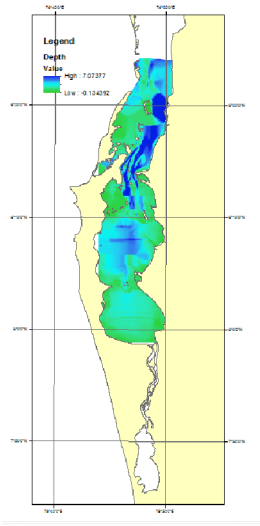


Fig 2.3- Puttalam Lagoon

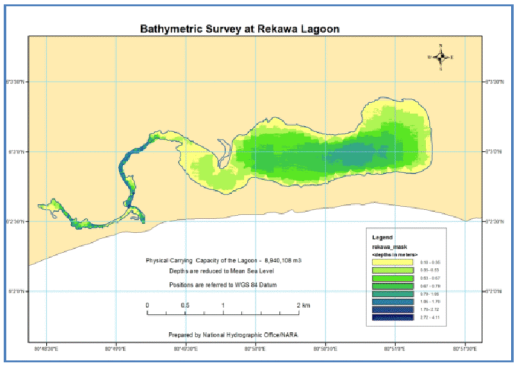


Fig 2.4 - Rekawa Lagoon

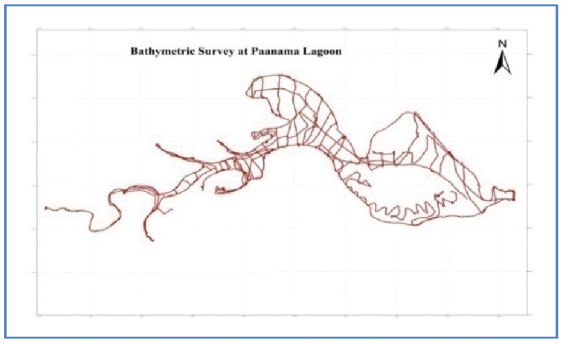


Fig. 2.5 - Panama Lagoons



Figure 2.6 - Field works at Kokilai Lagoon

SURVEYS CONDUCTED FOR SPECIAL REQUESTS FROM GOVERNMENT AND OTHER INSTITUTIONS

PROJECT NO : 3.1

BATHYMETRIC SURVEY FOR WALKERS COLOMBO SHIPYARD (PVT) LTD.

Walkers Colombo Shipyard informed National Hydrographic office (NHO) that they have lease agreement with Ceylon Fishery Harbor Corporation to utilize, develop and convert the Mutwal Fishery Harbour into a ship yard to carry out the ship repairs, building of boats & ships and to serve the local and foreign vessels and they have requested to carry out bathymetric survey at Mutwal harbour and channel. Accordingly NHO has successfully completed the project.



Figure 3.1- Survey platform

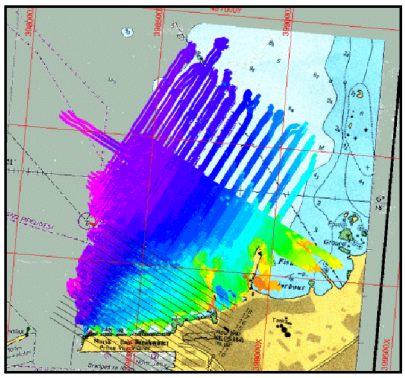


Figure 3.2- Bathymetric Survey at Mutwal Harbour

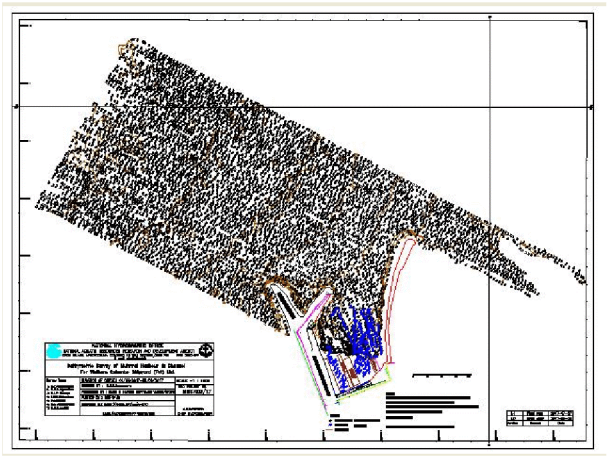


Figure 3.3- Final Map with Contours

PROJECT NO : 3.2

BEACH PROFILE AND BATHYMETRIC SURVEY OF COLOMBO PORT CITY DEVELOPMENT PROJECT

The government of Sri Lanka has designed to implement a reclamation project covering approximately 500 acres of sufficient land area between the Colombo Port Expansion Project site and the Galle Face Green to create a port city. According to the agreement signed between, China Harbour Engineering Company Limited (CHEC) , who is the contractor of the project , with the NARA , National Hydrographic Office (NHO) has conducted the beach profile surveys to monitor the physical characteristics of the sea bed and provide data to assess the potential impacts to seabed morphology/topography ,10 km North and 10 km South of the above proposed site.

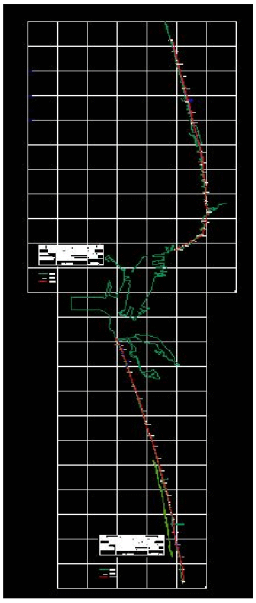


Figure 3.4- Final Profile Map

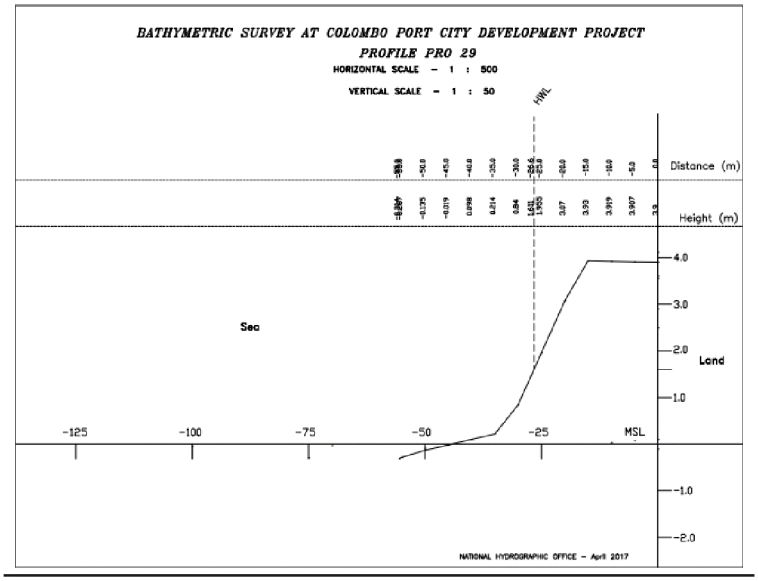


Figure 3.5.-Specific Beach Profile

PROJECT NO : 3.3

BATHYMETRIC SURVEY AT GANGEWADIYA FOR CEYLON FISHERY HARBOUR CORPORATION (CFHC)

Ceylon Fishery Harbour Corporation requested to carry out bathymetric survey at Gangewadiya area for the purpose of demarcating the area and to calculate volume to be dredged, Accordingly NHO completed this project.

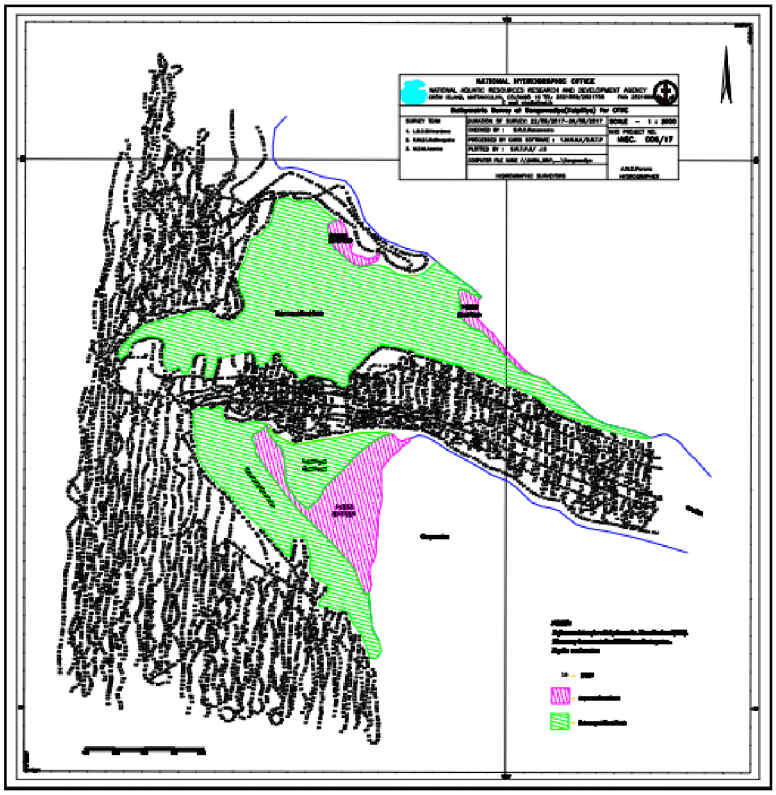


Figure 3.6- Final Map

PROJECT NO : 4.0
CONTRIBUTION FOR OTHER PROJECTS

PROJECT NO : 4.1
ASSISTANCE TO NOAC (NATIONAL OCEAN AFFAIRS COMMITTEE) TO DEAL WITH DELIMITATION OF THE OUTER EDGE OF THE CONTINENTAL MARGIN OF SRI LANKA.

Sri Lanka made it submission to the United Nation Convention on the Law of the Sea (UNCLOS) with respect to the Annex II of the final act of the Third United Nation Convention Law of the Sea adopted by the conference in 1980. Our submission relates to the delineation of the outer limits of the continental shelf of Sri Lanka by the specific method set forth in the Statement of Understanding.

As its scheduled by the main body of UNCLOS, the Sri Lankan submission is scheduled to be defend in the 2018. Therefore, the National Hydrographic Office of Sri Lanka provide its endeavor support for NOAC as per their requests to fulfill the criterions as it's mentioned in the Statement of Understanding.

The bathymetric data were collected to mark the Foot of Slope (FOS) points in the Eastern coast as per the request by Sub commission of UNCLOS to calculate the 1% sediment thickness.

In 2009, the Sri Lankan submission was mainly depending on the availability of data during that period. As per the request of sub commission, it was necessary to validate the model with the available seismic data in the Bay of Bengal Fan. The Geo Map App was used to process the analogue seismic data in the Indian Ocean to verify the Joe Curray maps, Robinowitz data, Sonobuoy Data, 1 km sediment thickness points and the 101 and 103 lines data.

- ***GeoMapApp*** is an earth science exploration and visualization application that is continually being expanded as part of the Marine Geosciences Data System (MGDS) at the Lamont-Doherty Earth Observatory of Columbia University.

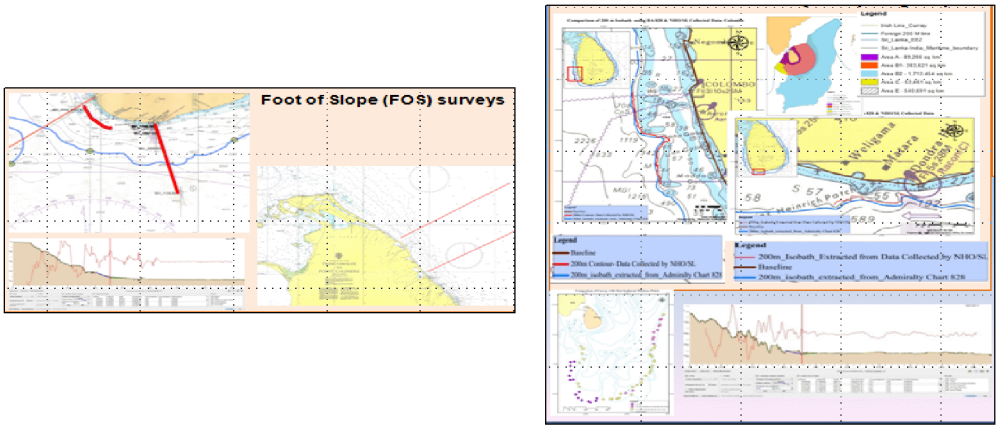


Figure 4.1- Supporting maps and data for NOAC



Figure 4.2 - Bathymetric Survey along the planned Foot of the Slope Lines

PROJECT NO : 4.2

MAPPING FOR POTENTIAL SITES FOR AQUACULTURE - NARA/NAQDA WILDLIFE JOINT PROJECT

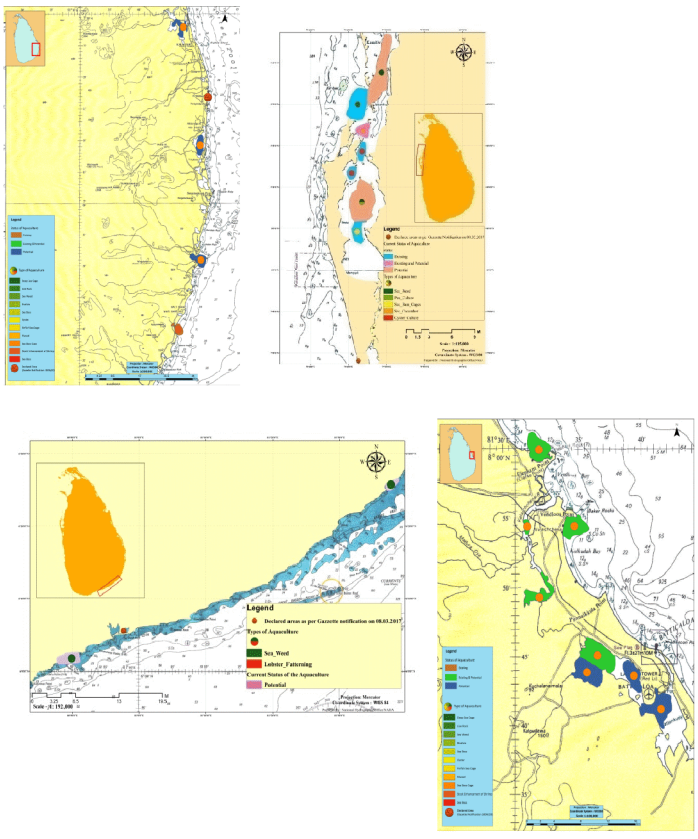


Figure 4.3 - Maps showing Aquaculture Potential Areas

PROJECT NO : 4.3

CONTRIBUTION OF PETROLEUM RESOURCES DEVELOPMENT SECRETARIAT (PRDS)

The Petroleum Resources Development Secretariat proposes to carry out an Environmental Baseline Study (EBS) in the offshore exploration blocks with a view to prepare for mandatory environmental impact assessments for future hydro-carbon explorations. These data would have the base for any future comparisons and accelerate the exploration process.

The EBS report is an integral part of any Environmental Impact assessment (EIA). This is an in depth analysis of all the data collected during the marine or terrestrial survey prior to exploration or development. This includes interpretation of bathymetric and sea bed features in conjunction with the sediment, physic-chemical properties of water, macro, & micro fauna and flora data. Considering the multiplicity of data, it is divided into four main study areas. They are sensitive coastal and marine habitats, marine mammals, meteorological and Oceanographic measurements and resource survey. NHO has been addressed adequately in the report for assigned areas and identified the research gaps to complete the anticipated objectives of the assignment. For the sensitive coastal and marine habitats, the eco systems such as coral reefs, sea grass beds, mangroves, shores, beaches, inter-tidal zone and sand dunes, lagoons and estuaries and salt marshes are considered. With respect to the above sensitive ecosystems, sea bed topography and description of marine archeological sites including wrecks (marine and aviation) and marine artifacts and sites with significant cultural value are addressed by NHO. Most of the data were presented in the forms of maps, charts and tables.

In the resource survey, most of the information on shipping routes under the theme of commercial and Non-extractive resources is addressed by NHO.

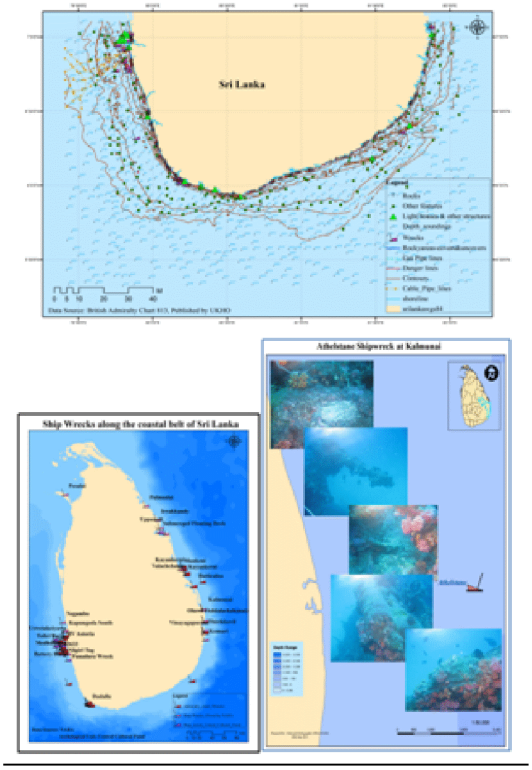


Figure 4.4 - Data and Information shared to PRDS database by NHO

Publications / Maps

1. Wijesundara WAAP, Ratnayake RMDI, Perera AND. (2017). Derivation of high resolution bathymetry from multispectral satellite images. Proceeding of the NARA Scientific Sessions 2017, Colombo, Sri Lanka.

2. Wijesundara WAAP, Ratnayake RMDI. (2017). Derivation of near shore bathymetry by using Landsat 8 Satellite imagery. Proceedings of the 23rd SLAFAR Annual Scientific Sessions 2017.

3. Lagoon Survey,
   - Map of Bathymetric survey at Kokilai lagoon
   - Map of Bathymetric survey at Rakawa lagoon
   - Map of Bathymetric survey at Panama lagoon
   - Map of Bathymetric survey at Negombo lagoon
   - Map of Bathymetric Survey at Puttalam lagoon

4. Map of Bathymetric survey – Mutwal harbor- Walkers Colombo Ship Yard.

5. Map of Land profiles survey – Colombo Port City Development Project.

6. Map of Bathymetric survey – Gangewadiya, Kalpitiyafor Ceylon Fishery Harbors Corporation (CFHC).

7. Map of Maritime Zones of Sri Lanka.

8. Map showing Potential sites for Aquaculture – NARA/NAQDA/Wildlife joint project.

Training / Awareness Programs conducted:

1. Environment and Educational Excursion of 57th Intake Officer Cadets, SL NAVY.

2. Study tour NARA & RV "SAMUDDRIKA", Department of Spatial Science of KDU Southern Campus.

3. Study tour – Hydrographic Surveying & Leveling B.Sc. in Fisheries and Marine Sciences degree program Ocean University of Sri Lanka.

4. Educational tour of 13th KDU (Technical) Intake Officers under Training under SL NAVY.

5. Study visit of undergraduates of the Faculty of Agriculture of the Research and Agricultural Institutions – University of Jaffna.

6. Educational tour of RP II "G" course Sri Lanka NAVY.

7. Study tour of Survey Recorder III Qualifying Course 01/2017 – Sri Lanka NAVY.

8. Environment and Educational excursion of 58th Intake Offices Cadets, Sri Lanka Navy.

9. Educational tour of Coastwise Navigation Course – Sri Lanka Navy.

10. Study tour for Nurses – Public Health Educational.

11. Onboard Hydrographic survey practical for students in Faculty of Geomatics, SUSL.

12. 15 weeks Industrial training for students Faculty of Geomatics, SUSL.

Foreign / Local Training and International Commitments

- No. of Officer 01: KOICA Programme for ENC Application, Korea Hydrographic and Oceanographic Agency (KHOA), Korea.



Figure 8.1 – KOICA Programme for ENC Application, KHOA, Korea

- No. of officer 01: Eumetsat- Sentinel 3- Using the Copernicus Marine Data Stream for Ocean Applications, UNESCO/IOC Project Office for IODE, Belgium



Figure 8.2 - Eumetsat- Sentinels 3- Using the Copernicus Marine Data Stream for Ocean Applications, UNESCO/IOC Project Office for IODE, Belgium

- 8.3 No. of Officer 01: Maritime Safety Information, Worldwide Navigational Warning Service Sub-committee, hosted by South African Hydrographic Office under IHO Capacity Building Programme, South Africa.



Figure 8.3 – Marine Safety Information, Worldwide Navigational Warning Service Sub-committee, hosted by South African Hydrographic Office under IHO Capacity Building Programme, South Africa.

- 8.4 No. of Officer 01 : Participation of North Indian Ocean Hydrographic Commission at Cairo, Egypt



Figure 8.4 - North Indian Ocean Hydrographic Commission at Cairo, Egypt.

- 8.5 No. of Officer 01: 1st Session of the IHO Assembly, Monaco.

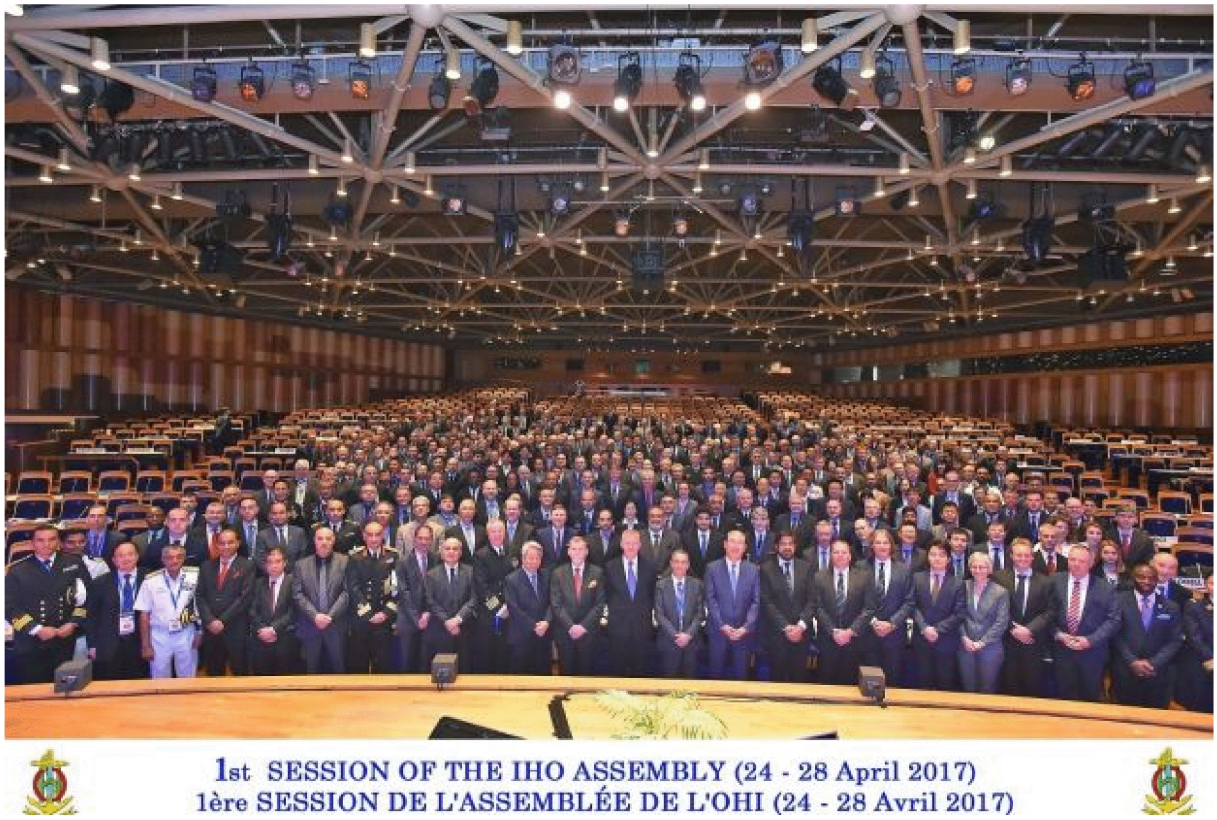


Figure 8.5 – 1st Session of the IHO Assembly, 2017

- 8.6. No. of Officer 01: Workshop on the Law of the Sea at General Sri John Kothalawela Defence University, Rathmalana, Sri Lanka.

Consultancy Surveys Conducted for special requests

Project	Contract Amount (Rs)
Bathymetric Survey at Gangewadiya to CFHC	125,000.00
Bathymetric Survey of Mutuwal Harbour and Channel for Walkers Colombo Shipyard	1,743,950.00
Petroleum Resources Development Secretariat Project (NARA Allocation)	37,000,000.00

Inland Aquatic Resources and Aquculture Division







5.4 INLAND AQUATIC RESOURCES AND AQUCULTURE DIVISION

Head of the Division : Dr.V.Pahalawattaarachchi

Summary

In 2017 division conducted 16 numbers of projects under 04 main areas; Ornamental fish/plant culture management, aquaculture development, fish feed development and health management in aquaculture. Under the ornamental fish culture, economically most valuable species *Sahyadria denisonii* and *Balantiocheilos melanopterus*, were targeted for development of breeding techniques. In that, most valuable baseline data leading to breeding such as optimum hormone concentration for induced breeding, larval feeding, increase survival using newly introduced Mc- Donald type hatchery jars were collected. Technology has been developed for captive breeding of endemic ornamental species, *Rasbora nigromarginata* through environment manipulation. *Puntius thimbiri, Rasbora nigromarginata, Laubuca insularis* and *Puntius kelumi are the* species which were newly introduced to the ornamental fish industry. Indoor (laboratory) culture technology was developed for *Spirulina,* highly nutritious blue green algae and two other most important micro algae, *Nannochloropsis* and *Chetocerous* mostly use in aquaculture, Developed mother cultures can be issued to the industry. Studies are being continuing for mass propagation/tissue culture which is a prime need to expand the seaweed industry in the country of the commercially growing seaweed species, *Kapaphycus alvarezi.* In this regard laboratory acclimatization method was developed in 2017. Mass micropragation technique was developed for the *Anubias barteri* var. *Nana* which is a economically high value species with higher export revenue which is supposed to introduce for the community based farming.

Community based oyster farming was popular among fisher folks during the past few years and there is a growing demand to expand the sector. Spat availability as well as collection are the main issues for the expansion so that introduction of efficient spat collectors is a continues process. Seaweed culture experiments showed that the most suitable propagule size for growing in the cages is 100g. Newly introduced round type cages at Dondra can be used to keep seeds of the *K. alverezii* during rough weather. Initial steps were taken for culture of *Ulva lactuaca.*

Nutritionally balanced economical feed formula for Asian Seabass fingerling culture in floating net cages Crabs can be cultured / fattened using formulated feed and according to the results, the experimental low cost feed formula have been developed and tested for crab culture. It can be suggested that, soy bean meal and/or meat n bone meal have been involved in the better growth in this study. It has been initiated to develop formulated feed for seacucumber and findings showed that feed replacement level of high value fish meals by brewers yeast closer to 10 % and lower to 30% in sea cucumber diets. Four fish feeds produced for ornamental fish at Panapitiya station. Income generation has initiated by selling, feed, fingerlings, brooders of Koi carps and excessive juveniles.

The studies completed on horizontal transmission of WSSV virus through wild carriers recommended that presently use crab meat and Mole crabs are suitable as broodstock feed in hatcheries, as higher percentage of the creatures are infected with WSSV. Biosecurity measures should be applied to avoid contamination of Sand white ghost crab, Mud crabs, Mangrove crabs with the grow out ponds. Ornamental fish disease surveillance programme revealed that prevailing diseases in high density were Gill/skin flukes and *Trichodina* infections in Gampaha, Kalutara & Galle districts. Severalty of disease is highest in July to August and guppy, sward tail, platy, and fighter fish were the most affected. The division has produced 04 full research papers and presented 22 abstracts during 2017.

PROJECT COMPLETION REPORTS-IARAD 2017

Project No	Title	Officers responsible	Budget (Mn)
1.7.1	Development of suitable breeding techniques for selected high value ornamental fish species	E.D.M. Epasinghe Amitha Adikari	1.3
1.7.2	Culture and captive/induced breeding technology development for endemic ornamental fish species and conservation of rare fish species	R.R.A. Ramani Shirantha	0.8
1.7.3	Micro Algae Culture and Technology Development for Selected Economically Important Marine Ornamental Species	M.A.J.C.Mallawaarachchi	1.2
1.7.4	Development of micro propagation method for selected aquatic plants and seaweeds, Genetic manipulation of *C.wendtii*	S.Sugeeshwari	0.99
1.8	Mariculture development with special emphasis on community based sea Cucumber farming in North and Northwestern province in Sri Lanka	P. A. D. Ajith Kumara C.B. Medagedara	1.50
1.9.1	Development of community based oyster and mussels culture in Puttalam lagoon	C.B. Medagedara S.Corea	0.97
1.10	Surveillance and development of screening methods for disease conditions in Ornamental fish industry in Three selected Districts	Dr. A.D.W.R.Rajapakshe	1
1.12	Fish feed development and ornamental fish production program at Panapitiya Regional Research Center	Champika perera M.Epasignhe	2.0
1.13.1	Development of formulated feed for Seabass culture in lagoon floating net Cages	D.A. Athukorala R. Weerasinghe	2.5
1.13.2	Use of Chitosan as an immunostimulant in tiger shrimp (*Peneous monodon*) feeds to resist viral diseases	R.Weerasingha Dr.K.D.N.Wickramaachihi	0.55
1.13.3	Development of feed for mud crabs	M. G. I. S. Parakrama	0.55
1.13.4	Effects of brewers yeast (*Saccaromyces cerevisae*) and Sargassum sp. On growth of Sea cucumber (*Holothuria scabra*) juveniles	R.Weerasighnhe	0.39
1.14	Development of culture techniques in selected seaweed species and quality improved parent stock maintenance of commercially important seaweeds	S. Jayanatha H. Galahitigma V.Pahalawattaarachchi	0.59
4.1.1	Management of Viral Disease in Shrimp Industry in Sri Lanka	M.L. Rasika Thanthrige	1.4
4.1.2	Effect of water quality and climatic adaptations in shrimp farming	A.S.L.E.Corea	0.8

PROJECT NO : 1.7.1

DEVELOPMENT OF SUITABLE BREEDING TECHNIQUES FOR SELECTED HIGH VALUE ORNAMENTAL FISH SPECIES.

Responsible officers : Mr. E.D.M. Epasinghe

Mrs. Amitha Adikari

Objectives:

- Development of suitable breeding techniques for *Sahyadria denisonii* and *Balantiocheilos melanopterus*
- Development of suitable hatchery technologies for *Sahyadria denisonii* and *Balantiocheilos melanopterus.*

Project background/ Introduction:

According to the Global IUCN red list *Sahyadria denisonii* and *Balantiocheilos melanopterus* are endangered species. Both species are highly demanding species in world ornamental fish trade. Export market of these species totally depend on the wild collection and yet the supply is not up to the demand, therefore value of these species still remain high and cost of importing fry or juvenile and re-exporting is high. Captive breeding of *Sahyadria denisonii* and *Balantiocheilos melanopterus* are still not successful and therefore no any authentic records of their captive breeding. With concern that, it is important to develop proper breeding technology with hatchery and rearing techniques of *Sahyadria denisonii* and *Balantiocheilos melanopterus* finally targeting the export market.

Activities carried out:

Collection of brood stock and rearing

Random samples of fish were collected from private ornamental fish importers. Fish were stock in glass tanks in quarantine area with 2 ppm Methylen Blue and 2 ppt salt solution for five days. Male and female brood-stock was reared separately in 300 cm X 300 cm X 300 cm cement tanks and continuous aeration was provided by using an aquarium air blower. Fish were fed with both artificial (42% protein containing floating feed) and live feed (*Artemia* nauphili and *Moina)* three times per day *ad libitum.*

Selection of brooders

As there is no distinct sexual dimoephism in these species; the only dimorphic character observed was that female has a slightly wider body than the male when sexually mature. Therefore, suitable males were selected as brood fish by checking the release of milt, when the belly was pressed or squeezed slightly. Selection of females was by observing the round, bulged belly and reddish papilla and the softness of abdomen. The same female brood-fish were subjected to the ovarian biopsy during the breeding experiment. Ovarian biopsies were carried out to determine the maturity of the ripe eggs by observing the position of the migratory nucleus of the eggs under the microscope. Forty female fishes were subjected to the ovarian biopsy and according to the position of nucleus and egg diameter fish were separated and stocked in 30cm X 30cm X 30cm glass tanks at the same stocking density. A fine polyethylene tube of 0.8mm inner diameter and 1.0mm outer diameter was used to get the egg samples. Serra's solution (60%Alchol:30Formalin:10 Gleceric acid) was used to clean the eggs and examined under the photomicroscope (3012 model).Since the brood fishes are very sensitive and handling stress can be lead to their mortality, the fish were anaesthetised before handling using Tricaine methane sulfonate (MS 222

tricaine, TMS) at 50-100 ppm concentration. Anesthetic bath was prepared by dissolving 150 mg /l of Tricaine methane sulfonate (MS 222 tricaine, TMS) in 3ml of water .Before the ovarian biopsy and administration of hormones, sedation was carried out.

Acclimatization of brooders

Selected male and female fishes were stocked separately in 300 cm X 300 cm X 300 cm cement tanks four weeks before the experiment at a stocking density of two individuals per m^2. Fishes were fed with *artemia* nauplii, *micro worm*, moina and vitamin E enriched minced ox-heart three times per day *ad libitum*. Each tank was provided with conditioned water and a constant aerator.

Breeding under captive conditions

Captive breeding of *Sahyadria denisonii*

In Captive breeding experiments of *Sahyadria denisonii* environmental manipulation methods and hormonal induced breeding methods were examined. Environmental manipulation methods were carried out in indoor glass tanks, outdoor cement tanks and flowing water system. Environmental manipulation experiments were repeated five times at two month intervals to increase the number of replicates. Hormonal induced breeding methods were examined using sGnRHa and LHRHa with different concentrations.

Breeding under indoor conditions

Four indoor glass tanks with a size of 120 cm X 60 cm X60 cm were used as spawning tanks. Bottoms of the spawning tanks were covered with aquarium gravels for a thickness of 5 cm and were filled with dechlorinated water to a depth of 30cm and allowed one day to settle the particles. Subsequently *Lagenandra ovatas* were paced at the bottom and aerated using aquarium air blower. Combination of male to female ratio was 1:1. Female fishes were selected based on ovarian biopsy results. Female fish having eggs with the nucleus at approximately the same position were selected as the female fish for trial. Spawning performances such as courtship and presence of eggs were the observations.

Breeding under outdoor conditions

Four cement tanks with a size of 160 cmX 100 cmX 50cm were used for spawning. Tank bottom were prepared using aquatic vegetation, wooden stumps and stones. Each tank was well aerated using aquarium air blower. Rest of the conditions was provided as in the indoor experiment.

Breeding under flowing water conditions

Four indoor glass tanks with a size of 120 cm X 60 cm X60 cm with continuous water flow were used as spawning tanks. Each tank was well aerated using aquarium air blower. Rest of the conditions was provided as in the indoor experiment.

Breeding using synthetic Gonadotrophin hormone

Same experiment set-up was used for hormonal induced spawning experiments. Female broods of 13-15g weight range were selected for induced breeding. Both female and male fish were given a single dose of hormone. Hypodermic syringes with a small size needle (1.5 cm length) were used to inject hormone intra-muscularly between the anterior region of dosal fin and lateral line.

Synthetic gonadotrophin hormone Ovaprim (SGnRH+Domperidone-Syndel laboratory, Canada) and LHRHa were used for induced breeding of fish. Males were treated with half the dose prior to females and introduced into experimental tanks. Different concentrations were tested as treatments (Table 1). breeding set comprising male and female in 1:1 ratio were kept together in glass tanks (150l) provided with continuous aeration and each treatment was triplicated.

It was observed that induced brood fish did not release eggs or milt by their own. After nine hours after the administration of the hormone hand stripping was carried out for both male and female. Eggs were collected to clean dry Petri-dishes. Milt of each male was made to fall on the eggs by gently pressing the abdomen and immediately mixed gently using a bird. Same water in the breeding tank was added and washed the fertilized eggs properly

Table 1 tested hormone concentrations

Ovaprim (mg/kg of body weight)		LHRHa (µg/kg of body weight)		Domperidon (ml/kg of body weight)	
Female	Male	Female	Male	Female	Male
0.4	o.2	20	10	0.5	0.5
0.5	0.25	30	15	0.5	0.5
0.8	0.4	40	20	0.5	0.5

Petri-dishes having fertilized eggs were incubated in 30cm x 30cm x30cm glass tanks. Same water that was used for breeding was taken to fill the incubation tanks also. Slight aeration was provided for each tank using an aeration pump.

Captive breeding of Balantiocheilos melanopterus

Hormonal induced breeding methods were examined using sGnRHa and HCG with different concentrations (Table 2.)

Table 2 Tested hormone concentrations

Ovaprim (mg/kg of body weight)		HCG (Iu/kg of body weight)	
Female	Male	Female	Male
0.4	0.2	500	250
0.5	0.25	2000	1000

Same experiment set-up was used for hormonal induced spawning experiments. Female broods of body weight 120-140g were selected for induced breeding. Both female and male fish were given a double dose

of hormone as 8 hrs interval. Hypodermic syringes with a small size needle (1.5 cm length) were used to inject hormone intra-muscularly between the anterior region of dosal fin and lateral line. Breeding set comprising male and female in 1:1 ratio were kept together in glass tanks (150l) provided with continuous aeration and each treatment was triplicate. After nine hours after the administration of the hormone hand stripping was carried out for both male and female. Eggs were collected to clean dry Petri-dishes. Milt of each male was made to fall on the eggs by gently pressing the abdomen and immediately mixed gently using a bird. Same water in the breeding tank was added and washed the fertilized eggs properly.

Measurement of water quality parameters

Water quality parameters in the each experiment were measured using following methods. Dissolved Oxygen and water temperature were measured with a DO meter (Pro ODO model) and pH was measured with a pH meter (pH6+ model). Total dissolved solids and specific conductivity were measured by a portable conductivity meter. Ammonia concentration and hardness of water were measured using a spectrophotometer (HACH).

Determination of duration of life cycle from hatchling up to adult

Time taken from egg to larval development was determined and recorded indoor to estimate the life cycle. The juveniles were observed at monthly intervals for the development of color and lines on the body.

Determination of initial feed of Sahyadria denisonii

A feeding experiment was conducted for 30 days with microworms, Artemia nauplii and Moina as the test feed. Nine indoor glass tanks (30 cm X 60 cm X 30 cm) were used for the experiment. As the high value exotic fish species captive breeding of *Puntius schwanenfeldii* was successfully done in 2016 using Ovaprim hormone at 0.4ml/kg of body weight for female and half dose for male. At that time the egg type of that species was found as semi-buoyant type, therefore, could not get higher survival percentage under normal hatching condition. In 2017 captive breeding experiments of *Puntius schwanenfeldii* was repeated and hatching of eggs were done using MC-donald hatchery jars. Due to success of hatching of eggs, suitable initial fed for 5 days old larvae of *Puntius schwanenfeldii* was identified using *Artemia* nauplii (100%), moina, micro-worm and 50% *Artemia* + egg yolk (50%). To find out suitable stocking density for *Puntius schwanenfeldii* 45 days old fry were stocked at 100 larvae/m^2, 200 larvae/m^2 and 300 larvae/m^2.

Results:

Out of the two different captive breeding methods of *Sahyadria denisonii,*, spawning was observed only in hormone induced breeding method. Respect to the environmental manipulation methods, courtship behaviour could be observed only in tanks which did not possess flowing water at 90 cm water depth having a water temperature of 28.2±0.3 and pH 6.4±0.2. After introduction into indoor and outdoor tanks with aquatic vegetation, males and females exhibited active swimming movements and chasing behaviour (males chasing females) on the following day in the morning around 8.30 am. But females did not release ova. Female fish with a mean egg diameter of 1.6±0.2mm were used for induced breeding experiments (Table 3). *S. denisonii,* which received Ovaprim hormone at a concentration of 0.5 mL/kg of body weight spawned. Spawning did not occur in any other treatment.

Table 3 Mature Lengths & Weights and egg size of *S. denisonii*

	Parameter	Mean±SD
Female	Total length at maturity (cm)	14.0±0.2
	Total weight at maturity (g)	13.4±1.6
	Mean egg diameter (mm)	1.6±0.2
Male	Total length at maturity (cm)	15.1±1.0
	Total weight at maturity (g)	21.9±0.7

Nine hours after the injection, Hand stripping was carried out. At this stage, ova came out freely only female fish which received Ovaprim hormone at a concentration of 0.5 mL/kg of body weight. The eggs were adhesive and sunk to the bottom. However, hand stripping was not successful in any other treatment. Courtship behaviour could be observed in all the treatments. All the fish, which received 30 µg kg^{-1} and 40 µg kg^{-1} LHRHa died twelve hours after the hormone administration. Fertilized eggs were spherical and orange-brown with a diameter of 1.6±0.2mm. Eggs hatched within 36 h after fertilization at 28.8±03 ^{0}C and immediately after hatching crawling movements were observed in hatchlings with the yolk sac. Yolk sac got absorbed within 2-3 days and the post-larvae were colourless unlike their adults.

Table 4. Spawning performance of *S. denisonii*

Performance of a or mean spawner[1]	Mean ± SD
Number of eggs laid	216±33
Percentage of fertilized eggs	65±7
Percentage of hatchlings	52±8
Length of a hatchling (mm)	3.5±0.2
Weight of a hatchling (mg)	0.04±0.5
Latency period (h)	9

[1] Total length: 14.0-14.5 cm, Body weight: 13.0-14 g

Free swimming larvae were observed on the fifth day. The mouth moved vigorously in search of food. Larvae exhibited grouping behavior (Fig.1).

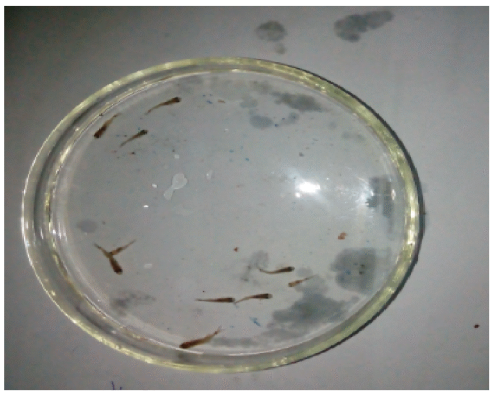


Fig.1. Five-Day old *Sahyadria denisonii* post-larvae

One month old larvae had a mean total length 15.0±0.2mm. Four vertical black bands were distinctly marked. The body coloration was yellowish dorsally and creamy white ventrally (Fig 2).

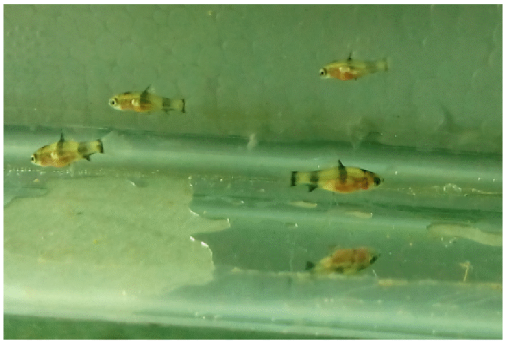


Fig.2.One month old *Sahyadria denisonii* larvae

Three months old larvae had a total length of 28±0.2mm. A black line was observed along the lateral side of the body and the caudal fin was tipped with black and yellow bands (Fig. 3).



Fig. 3 Three months old *Sahyadria denisonii*

the three tested diets, *Artemia* nauplii produced significantly length gain and SGR-L while they were lowest for micro-worm and moina diet ($p<0.05$). However, *Artemia* nauplii and micro-worm diets produced higher survival percentage and were not significantly difference. Therefore it could infer that even though hatchling fed on micro-worms at initial stage showed comparatively lower growth, the micro-worm could still be used for the rearing of hatchlings of *S. denissonii*. Lower growth performances and survival percentage for moina diet may be partly due to the size of the diet not compatible with mouth size of hatchlings.

Table 5 Growth performances of *Sahyadria denissonii*

	Mean[1]± SE		
	Artemia	Micro-worm	Moina
Mean Initial length (mm)	3.5[a]0.2	3.5[a]±0.2	3.5[a]±0.2
Mean Final length (mm)	15.0[a]±0.2	13.9[b]±0.48	9.8[c]±0.45
Mean Length gain (mm)	11.5[a]±0.1	10.4[b]±0.28	6.3[c]±0.26
SGR-L	3.01[a]±0.14	2.73[b]±0.13	2.17[c]±0.10
Survival %	95	93	30

[1] value within rows followed by different superscripts are significantly different (p, 0.05)

Balantiocheilus melanopterus induced breeding trial was successful with 0.5 mL/kg Ovaprim hormone in two doses as ⅓ and ⅔ in 8 hr intervals. Latency period was 8 hours, Average number of eggs 7029 ± 78, diameter of the egg at the maturity was 1.2 ± 0.6 mm. Spent eggs swelled few minutes after touching water therefore, utilized special hatching equipment called Mc Donald jars for hatching eggs. Embryonic development was stoppage at Blastula stage.

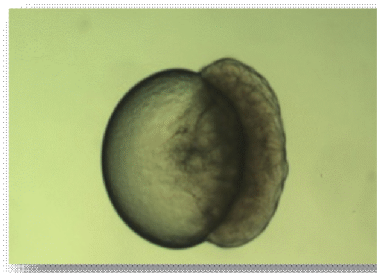


Fig 4: Egg development up to Blastula stage

Puntius schwanenfeldii was successfully bred using 0.4ml/kg of ovaprim. Latency period was recorded as 6hrs (Table 6) The survival rate of post larvae were increased 97%±5 using MC-Donald type hatchery jar compared with normal hatching tanks.

Table 6: Spawning performance of *Puntius schwanenfeldii*

Hormone	**Ovaprim (GnRHa)**
Successive dose	0.4 $mLkg^{-1}$ single
Eggs spent after	6 hours
Egg type	Semi buoyant
rate	75 %
Avg: No of eggs	> Fertility *7000*

During the egg hatching using Mc Donald jar Spent eggs swelled few minutes after touching water and also it is essential to keep eggs in a suspension using Mc Donald jar.



Fig 6: *Puntius schwanenfeldii* eggs hatching using Mc Donald jar

Initial feed trail was done for *Puntius schwanenfeldii* five days old larvae using *Artemia* nauplii (100%), moina, micro-worm and 50% *Artemia* + egg yolk (50%). According to that study *Artemia* nauplii (100%) fed larvae shows significantly highest growth. After 30 days feeding mean length and mean weight was recorded as 15.68±0.07 mm and 0.08±0.02 g respectively. Three stocking densities (100 larvae/m^2, 200 larvae/m^2 and 300 larvae/m^2) were studied for 45 days old *Puntius schwanenfeldii* larvae and highest survival percentage was recorded for 200 larvae/m^2 density.

Recommendations:

- *Sahyadria denisonii* can be successfully breed using a single dose Ovaprim at 0.5 mL/kg of body weight of female and half the dose for the male.
- *Artemia* nauphili and Micro-worm could be given as the starter feed for *Sahyadria denisonii* post larvae.
- *Mc- Donald typ2 hatchery jars must be used to get the high survival percentage of Puntius schwanenfeldii larvae*

Progress: Physical : 91% Financial

Output:

Introducing developed breeding technique/s for *Puntius denisonii* and *Balantiocheilos melanopterus*

Outcome:

- *Decreasing the quantity of imported Sahyadria denisonii and Balantiocheilos melanopterus*
- *Enhancing income of fish breeders and fish exporters.*

Constraints:

- *Brood-stock management was difficult under existing tank facility*
- *Acute outbreak of fish disease/White spot (Ichthyophthirius sp.)*

PROJECT NO : 1.7.2

CULTURE AND CAPTIVE/INDUCED BREEDING TECHNOLOGY DEVELOPMENT FOR ENDEMIC ORNAMENTAL FISH SPECIES AND CONSERVATION OF RARE FISH SPECIES.

Responsible officer : Ms. Ramani Shirantha

Objectives:

- To develop better technologies for culture, breeding and rearing of selected endemic ornamental fish species.
- To introduce new native ornamental fish species to the ornamental industry.
- To conserve rare threatened fish species e.g. *Systomous asoka*, and *Labeo fisheri.*
- To identify different *Labeo* spp.

Project background/ Introduction:

Sri Lanka has blessed with over 24 attractive endemic fishes but only 15 are used in tropical ornamental fish industry, others are underutilized. Sustainable use of such species is hinder due to lack of developed breeding & culture technologies. In this regards we need to develop indoor aquarium facilities at NARA for

better performance. Continuous decline in wild populations of some endemic fishes has become major conservation issue now (Redlist 2012). *Systomus asoka* is such critically endangered species that urges immediately adopted conservation measures. Department of Wildlife Conservation has already made request to develop captive breeding techniques in particular for its conservation and management. As the national body NARA has to make recommendation on sustainable use, conservation & management of native fish fauna. Therefore, we need to have an updated database with understand ecology and biology. Concerned to all above facts, the 1.7.2 project was conducted.

Activities carried out:

Study on *Systomous asoka*

Study on the wild populations of *Systomous asoka* in two streams *viz.* Girankittha Oya at Kitulgala and Seethawaka Ganga at Deraniyagala was carried out at two monthly intervals with in situ records of selected water quality parameters and the visual count of each site population (see figure 1). Possible sites to relocate or reinforce the existing population of this rare species within its distribution range at Seethawaka Ganga catchments were identified. In March 2017, a total of 12 individuals of 3-4 cm in total length were collected from Girankittha Oya and transported to NARA, and reared in three pairs at 2½×1½×1½ glass tank and outdoor cement tank of cobbles and *Valisnaria* and *Hydrilla* plants cover. Sexing was done in May, and introduced them to two separate tanks and fed with chopped ox-heart twice a day. The water quality parameters at each tank were measured biweekly. However, all individuals at the indoor glass tank died due to white spot disease. In August, another brooder stock was collected but they also died suddenly due to decreased level of pH (4.85) at the rearing tank. The heavy rain with thunders occurred at the previous day was identified as the factor for sudden drop in pH. Due to facultative white spot disease condition at NARA as well as low abundance in wild the brooder collection of this critically endangered protected fish species was not continued further.

Study on different Labeo species in different river basins

Study on different *Labeo* species in different river basins *viz.* Mahaweli Ganga, Kala Oya, and Malwathu Oya was carried out. They were differentiated into different taxa just observaing and measuring the morphological characters. Although it was originally proposed to carry our molecular level identification it had to postpone due to legal constrains.

Captive breeding of Rasbora nigromarginata and R. wilpita

Rasbora nigromarginata and *R. wilpita Rasbora nigromarginata* and *R. wilpita* A total of 20 and 10 wild *Rasbora nigromarginata* and *R. wilpita* were reared at 10'×8' community fish tank at 1½ water level. In June and October, the experiments on captive breeding of *Rasbora wilpita* (4.5-6.0cm total length) and *Rasbora nigromarginata* (3.5–3.7cm total length) respectively done through induced breeding and environment manipulation method in 3:1 sex ratio (female to male). Of them only *R. nigromarginata* successfully bred in cement tank under the condition given in table 1. Their larvae were fed with bread worm, *Artemia* and *Caridina* shrimp twice a day over 2½ months.

Study on wild populations of endemic fishes

Three Ichthyological surveys were conducted at Girimale area.

Experiment to check fertility criterion to delimit two closely related endemic fish

Another experiment was initiated to check fertility criterion to delimit two closely related endemic fish species i.e. *Pethia cumingii* × *Pethia reval* those have already led to a controversial taxonomic issue and their larval rearing is in progress.

Upgrading culture and fish rearing facility at the indoor aquarium

Upgrading culture and fish rearing facility at the indoor aquarium was initiated, and a new roof ceiling was constructed to reduce to heat trapped inside. As usual breeding of the endemic ornamental fish species was continued for which the captive breeding technologies have already been developed.

Results:

Study on Systomus asoka (Asoka barb)

Study on the wild populations and rearing of *Systomous asoka* at NARA revealed that it is a very sensitive fish species, requires very special micro-climate condition that is difficult to duplicate in tankerized condition. Its subpopulation at Deraniyagala area is at high risk of extinction, needs proper conservation action. The estimated average population density was 0.18 individuals/km^2. Such low population density may be due to water quality depletion in the habitats as well as due to riverscape modification with the construction of mini hydro dams in upstream area. The water quality parameters measured evident low down of quality recording high values for major nutrients viz. Nitrite, Nitrate and Phosphate were 0.076 mg/l, 0.178 mg/l and 0.238 mg/l respectively. These were relatively higher compare to those in Girankkitha Oya (0.004 mg/l, 0.24 mg/l and 0.006 mg/l) in which *S. asoka* inhabits with good population density (figure 1, 2 & 3).





Plate: 1 & 2 studying on *Systomus asoka* at Deraniyagala, Rakwanawa Oya & Magal Oya.

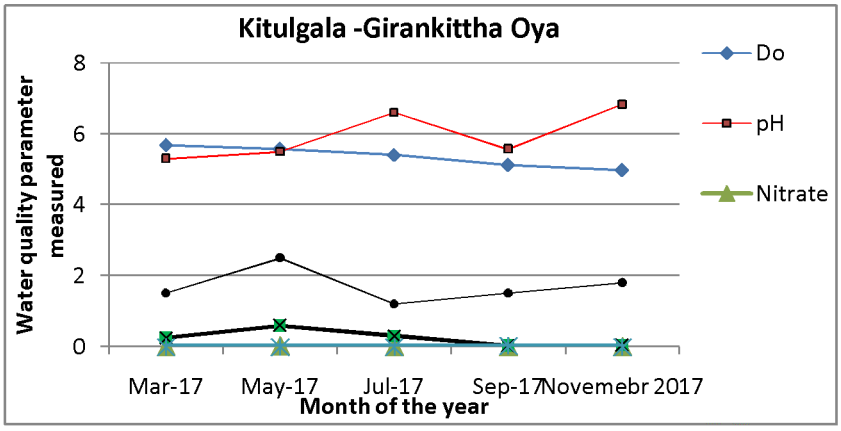


Figure 1: variations in water quality parameters measured at Girakitthan Oya, Kitulgala in 2017 (Key: Do; Dissolved Oxygen (mg/l), pH, Nitrate (mg/l), Nitrite (mg/l), Phos: Phosphate (mg/l), flow rate: water velocity (m/S).

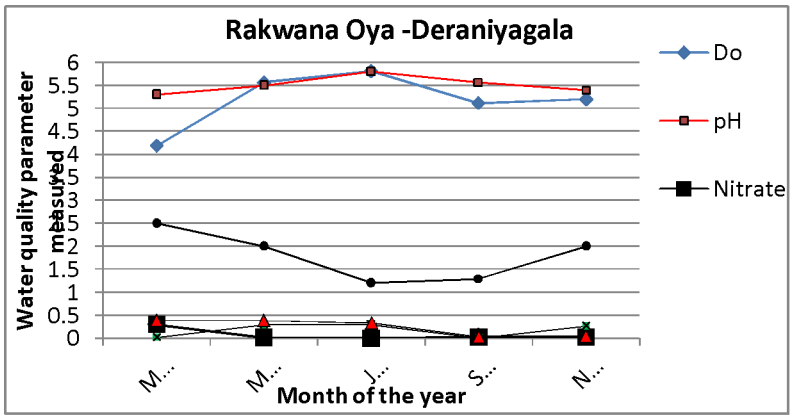


Figure 2: variations in water quality parameters measured at Girakitthan Oya, Kitulgala in 2017 (Key: Do; Dissolved Oxygen (mg/l), pH, Nitrate (mg/l), Nitrite (mg/l), Phos: Phosphate (mg/l), flow rate: water velocity (m/S).

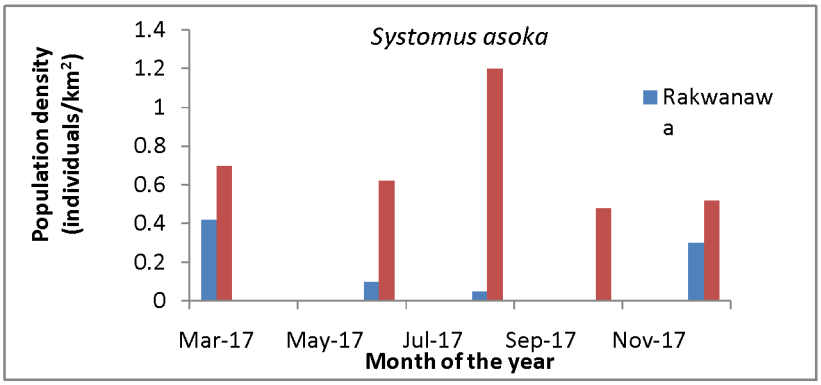


Figure 3: Variation in population density of *Systomus asoka* at two study sites at two monthly intervals in 2017.

Study on Labeo species

The present study revealed that *Labeo fisheri* is found in 14 river reaches (figure 4) but only 6 river reaches are within the protected area net work of the country. In particular, the Knuckle Conservation Forest Area (KCF), Anga-medilla and Wasgamouwa National Parks and Victoria Randenigala Rantambe (VRR) Sanctuary grant secure. Hitherto *L. fisheri* in all recorded river reaches get fishing pressure up to some extent. The estimated total occupancy area of *L. fisheri* is approximately 100km^{-2} in Matale, Kandy, Badulla and Polonnaruwa (very small area) districts. There is a viable population of *L. fisheri* in the river reaches in Kandy and Matale districts. Study on different *Labeo* species revealed that there are four native *Labeo* species as well as few more unidentified species in Malwatu Oya and Gal Oya catchments (plate 3).



Labeo sp. in Kala oya



Labeo sp. in Mahaweli Ganga



Labeo sp. in Heen Ganga

Plate 3: identified tree different native fish species that are considered as *Labeo fisheri*.

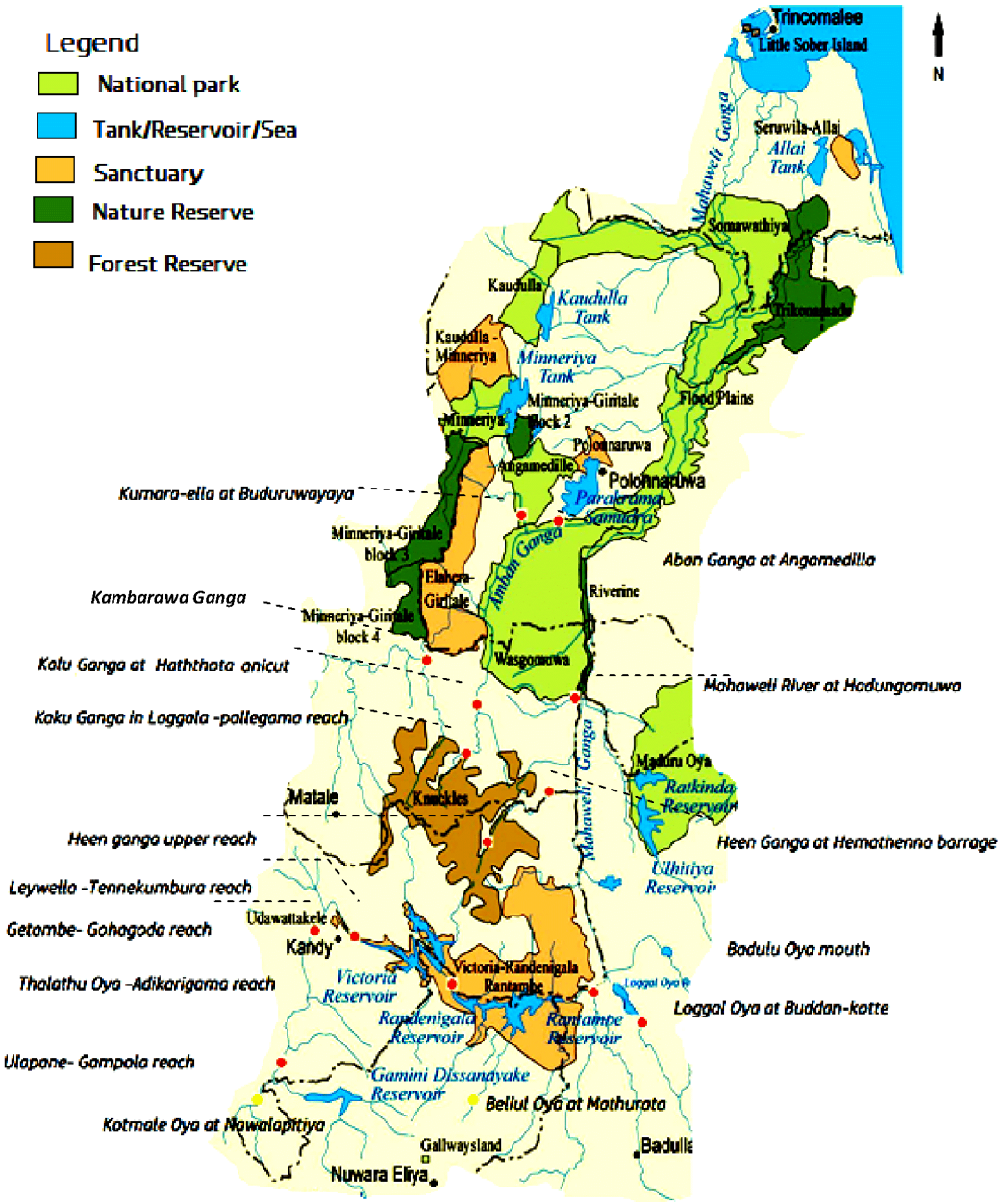


Figure 4 map of the Mahaweli River system showing 14 river reaches where *Labeo fisheri* recorded.

Breeding of endemic fishes

R. nigromarginata was successfully bred in cement tank under condition give in table 1 and this was ever first captive breeding record of this species in Sri Lanka.



Plate 4 *Rasbora nigromarginata* (3.5 cm); rare endemic fish species confined only to Baduraliya area.

Table 1 average value of some water quality parameters at the breeding tank of *R. migromarginata*.

Water quality parameter	Average
Water temperature (°C)	27.25
pH	5.75
DO (mg/l)	5.21
Nitrite (mg/l)	0.005
Nitrate (mg/l)	0.29
Alkalinity (mg/l)	08.25
Harness (mg/l)	16.00
Phosphate (mg/l)	0.165
Total Ammonia (mg/l)	0.180

Another experiment was initiated to check fertility criterion to delimit two closely related endemic fish species i.e. *Pethia cumingii* × *Pethia reval* those have already led to a controversial taxonomic issue and their larval rearing is in progress.

Ichthyological survey in Girimale protected area



Plate 5 Newly identified hill stream loach species, tentatively named as *Schistura upaliei.*

The survey conducted in Girimale area recorded a total of 17 endemic fish species with possibly un-described hill stream loach species as given in plate 5.

Upgrading NARA fish culture and rearing facilities

BOQ and purchasing of goods were completed to renovate the shelter of outdoor fish tank system but construction work delayed due to busy schedule of relevant officers at the Service and Operation Division.

Recommendation

- It is recommended to declare natural habitats of *Systomus asoka* (Asoka pethiya) in Kelani river basin as wildlife reserves as its *in situ* conservation is very important together with habitat restoration program as a public-community participatory project.
- *Rasbora nigromarginata* can easily be bred in captivity through environment manipulation and can be rare in community tank. Promotion of this species as ornamental fish is recommended.

- Based on 2017 research work it can be concluded that induced breeding of endangered Rasbora wilpita is possible with identification of correct ovulation period. Since its range expansion was found

to higher than previously known range and good populations are found in Nilwala, Kelani river and Kalu river basin it is recommend degrade to a non-protected species enabling to use in ornamental fish industry.

Progress: Physical : 85% Financial :

Outputs:

- Report on current population conservation status of *Systomus asoka*, submitted to Department of Wildlife Conservation.
- Two book chapters based on long term studies on the endemic fishes.
- One symposium paper on endemic fish species *Labeo fisheri.*
- Breeding technology for *Rasbora nigromarginata.*
- Information on effect of micro climatic changes in low order streams.
- Four new endemic fish species to be popularized as ornamental fishes.



Puntius thimbiri



Rasbora nigromarginata



Laubuca insularis



Puntius kelumi

Plate 6 identified potential endemic ornamental fish species.

Outcomes:

- Our research findings led Systomus asoka to become one of five most concerned species of Sri Lanka, which would get special attention of DWC.
- Built awareness in university students, custom officers and other interest people and authorities on use and importance of endemic fishes.
- Identified four potential endemic ornamental fish species of developed captive breeding technology (plate 6).

Constraints:

- Facultative pathogenic disease outbreak of White Spot Disease.
- Legal constrain to collect the endemic species in protected areas to have molecular level studies
- Delay in reconstruction of roof system and shelters for at outdoor ponds.

PROJECT NO : 1.7.3

MICRO ALGAE CULTURE AND TECHNOLOGY DEVELOPMENT FOR SELECTED ECONOMICALLY IMPORTANT MARINE ORNAMENTAL SPECIES

Responsible officer : Mrs. M.A.J.C. Mallawa Arachchi

Objectives:

- To extract and maintain mother cultures of commercially important algae species (*Chaetoceros sp., Nannochloropsis sp., Isoschrysis galabana, Spirulina sp.).*
- To establish laboratory and outdoor culture procedure for Spirulina sp.
- To study growth performance of seahorse fry fed with two different live feed enriched with two different algae species.
- To study growth and reproductive performance of seahorse in cage culture
- To study reproductive performance of marine ornamental shrimp
- To investigate the different substrate on the culture and growth of polycheate

Project background/ Introduction:

Sri Lanka received great amount of foreign exchange from marine ornamental fish. All these species are collected from the wild and the technology to captive breeding and culture is far behind than freshwater ornamental fish breeding and culture. Technology development to breed and culture marine ornamental fish is vital in present aquaculture sector in Sri Lanka. Hence, this project aimed to develop technology to breed marine ornamental species in captive condition.

Live feed play major role in fish and shell fish culture in Sri Lanka. Since there is a difficulty in reaching reliable micro algae culture protocols and for mother cultures, this project targeted to develop feasible culture protocols and maintain mother cultures for marine algae.

The major barrier to improve shrimp production in Sri Lanka is controlling viral infection in hatchery to grow out stage. Disease free feed production for brooders is important in hatchery condition and this project aimed to develop disease free polycheate culture technology. This project was suggested by shrimp hatchery owner in the stakeholder meeting.

Activities carried out:

Algae culture

Spirulina culture - *Spirulina* was cultured in two different media viz. Bold basal medium and Zarrouk's medium. *Chetocerous* and *Nannochloropsis*mother cultures were maintained in the laboratory.

Facilities development activities carried out for algae culture.

Seahorse culture

Site and community were selected to seahorse cage culture at Munnakkaraya , Negombo. Cage construction was carried out with NARA staff and the community. The brooders were collected from Kalpitiya lagoon and transported to indoor hatchery at NARA. Fry obtained from one female were taken to an experiment. An experiment was conducted to study growth and survival of seahorse fry in green water

aquaculture. Fry were subjected to two treatments and to the control. Fry in treatment 1 were grown with *Chetocerous* and fry in treatment 2 were grown with *Nannochloropsis.*

Marine ornamental shrimp culture

Adult *Lysmata debelius* brooders were collected from Negombo were transported to the hatchery at NARA. Nauplii obtained from one adult were subjected to feed algae (*Chetocerous)* in the hatchery. Growth parameters of shrimp nauplii were checked.

Polycheate culture

Polycheate collected from Negombo lagoon were introduced to four different substrates. All the substrate disinfected with 5% Sodium hypochlorite.

1. Lagoon bottom soil
2. Lagoon bottom soil mixed with cow dung
3. Lagoon bottom soil mixed with chicken manure
4. Lagoon bottom soil mixed with kitchen waste

Initial weight of polycheate in each tank was measured.

Results:

Algae culture

Spirulina culture – Spirulina grown in Zarrouk's medium were shown growth however bold basal medium was not succeeded in *Spirulina* culture.

Chetocerous and *Nannochloropsis* culture – provided mother cultures to required communities such as Universities, Seacucumber hatcheries, Marine ornamental hatcheries etc.

Laboratory development **-** Completed fully equipped laboratory for algae culture

Seahorse culture

Cage construction completed at the selected site. Seahorse fry in the green water culture experiment shown the highest survival (76.7%) in *Chetocerous* medium and fry cultured with *Nannochloropsis* shown 66.6% survival while in the control tanks it was 50%.

Marine ornamental shrimp culture

Lysmata debelius nauplii grown up to 5 days (algae feeding period) with *Chetocerous.* Experiments continuing to carry out *Lysmata debelius* zoea to grow with zooplankton.

Polycheate culture

Polycheate were in all tanks dead within two days. The experiment continuing with alternative substrate disinfecting methods. The Polycheate genus identified is *Nereis*.

Progress: Physical: 67% Financial

Output:

- Successful growth media for *Spirulina* laboratory culture
- Supplying required algae culture to necessary communities.
- Green water culture technology application in seahorse culture

Outcomes:

- Developed indoor (laboratory) culture technology for *Spirulina*
- Developed technology for seahorse fry nursery culture.

Constraints:

Delay in purchasing of net material to due date made it impossible to initiate seahorse brooder experiments in cages prior to rainy period. Therefore, the brooders matured in the hatchery and obtained fry for feeding experiments.

PROJECT NO : 1.7.4

DEVELOPMENT OF MICRO PROPAGATION METHOD FOR SELECTED AQUATIC PLANTS AND SEAWEEDS. GENETIC MANIPULATION OF *CRYPTOCORYNE WEDTII*.

Responsible officer : Mrs. D.M.S. Sugeeshwari

Objectives:

- To develop suitable culture method for aquatic plants and seaweed.
- To identify best media composition for better results in tissue culture of aquatic plants and seaweeds.
- To enhance genetic improvement of C. wendtii.

Project background/ Introduction:

Aquatic ornamental plants are used for the decoration of ponds or aquaria. Among the aquatic ornamental plants *Anubias, Cryptocoryne, Echinodorous, Aponogeton, Microsorium* are among modern day ornamental aquarium plant. The export demands for those plants are rapidly increases. *Anubias* and *Microsorium* species have high values in aquatic plant industry. Lacking of properly developed culture techniques is the main problem in the aquatic plant industry. Therefore, introduction of such micro propagation technology is much important. Seaweeds are important candidates in mari-culture sector for the careegeenan production. Lack of seeds for their vegetative propagation is main barrier in developing industry. Therefore, introducing of such micro propagation methods is important.

Activities carried out:

- Mother plant maintenance at the plant house at NARA.
- Culture and sub culture of the aquatic ex-plants in the tissue culture laboratory.
- Collection of the seaweeds from the field.
- Acclimatized the seaweeds in plant house.
- Culture in laboratory for callus development.

Results:

The best media composition for *Anubias barteri var. Nana* was Murashige and Skoog media with 4mg/L Benzyle adenine purine growth hormone (BAP).

Progress: Physical : 78% Financial

Output:

Contributed to the growth of the aquaculture sector by developing aquatic plant culture technologys

Outcome:

Best culture media for the *Anubias* shoot initiation

Constraints:

- High phenol content in Microsorim species consist resulted browning of the explants once they cultured at laboratory condition.
- Less survival rate of the seaweed cultured at the laboratory, and it was identified as the main barrier for development of propagation method for seaweeds.

PROJECT NO : 1.8

MARICULTURE DEVELOPMENT WITH SPECIAL EMPHASIS ON COMMUNITY- BASED SEA CUCUMBER FARMING IN NORTH AND NORTHWESTERN PROVINCES IN SRI LANKA

Responsible officers : Mr. P. A. D. Ajith Kumara

Mr. C.B. Medagedara

Objectives:

- Initiate and monitoring of alternative livelihood programmes through transferring technical know-how of sea cucumber farming to public and private sectors
- Development of breeding, culture and grow-out techniques of economically important sea cucumber species
- Provide biological benefits to society by aiding stock recovery
- Address and cater to the issues in sea cucumber farming

Project background/ Introduction:

Puttalam lagoon (7° 44'46-8° 35'60 North and 79° 48'25-79° 49'17 East) is considered one of the most productive lagoon in Sri Lanka. There are 88 fishing villages around the lagoon and about 165,000 people directly or indirectly dependent solely on Puttalam lagoon fisheries, including nearly 6,000 fishing directly in the lagoon. Habitat destruction and over-exploitation of fishery resources are the major biggest threats affecting to the Puttalam lagoon and its associated environment. Vast areas of mangroves and salt marsh habitats continue to be cleared for various development activities such as salterns, coconut cultivation, tourism development, wind mill construction and temporary settlements.

The lagoon and adjacent coastal waters are famous for exploitation of edible sea cucumbers since past An increasing number of households in these coastal areas see their livelihoods endangered by declining fisheries catches. It is also predicted that unexpected climatic changes in the area will cause changes in the fin fish and shell fish catches considerably which ultimately affects livelihoods. Acceptable livelihood alternatives such as sea cucumber culture has a good potential to become a popular policy to uplift the socio-economic status of small-scale fishers and to reduce fishing pressure on over-exploited fisheries. This activity is also important as a fisher-women empowerment Community-based sea cucumber farming has been also identified as a promising livelihood method for uplift the socio-economic status of the vulnerable fishing communities those who suffer from their income sources due to lack of fishery resources. We are concerned with technology development and adoption by NARA and have therefore given explicit consideration to its fit within the strengthening alternate livelihoods portfolio of poor people.

Activities carried out:

Participatory Rural Appraisal (PRA) Method

Whereas site selection procedures for initiate community-based sea cucumber farming and natural releasing, the key challenges were to ensure that any strategy for poverty reduction must support and promote sustainable rural development in the area concerned. We got better idea of acceptability and relevance through the livelihoods analysis during our short period rapid survey. Survey results revealed that the sustainable livelihood approach in any development intervention must fit within the house-hold economy, which is usually based around multiple income sources. During PRA we recognized that top-down approaches do not work and form the outset of the research then we have attempted to follow a participatory approach working with all beneficiaries as some people had already acquired experiences on aquaculture related livelihoods i.e. sea bass cage farming, seaweed farming and oyster farming. In the selected area, around 100-150 fishing families are directly or indirectly dependent on the sea cucumber fishery for their livelihoods.

Site selection

Potential areas for sea cucumber farming and wild releasing have been identified using sources including coastal survey maps, soil maps, hydrological maps, navigation charts, past studies (both published and unpublished) and primary data (including anecdotal evidences) collected by the survey team in the field (Fig. 1). Some on-going research activities carried out by NARA (i.e. on small mooring system) was used to routine monitoring work of selected water parameters (Fig. 2). Finally, the suitable areas for community-based sea cucumber framing and wild releasing for stock enhancement has been identified in the Puttalam

lagoon by in-cooperating ground routing data in to GIS maps. The survey of the study area was encompassed along the west coast line of lagoon and around Isles from Kalpitiya to Dutch Bay.

Criteria were identified which impact the development of sea cucumber grow out farming technology. These include lagoon depth, salinity, soil texture, sea grass vegetation, user conflicts, access to infrastructure and water quality. The criteria were defined by subdividing them into parameters. The relative importance of each parameter was scored on a scale of 0 to 3. Zero is used to eliminate low and hyper saline areas such as close to river mouth and very far from sea mouth or wholly unsuitable sites. The score of each parameter is the product of the criteria by parameter rank. The selected sites are highlighted in figure 3.

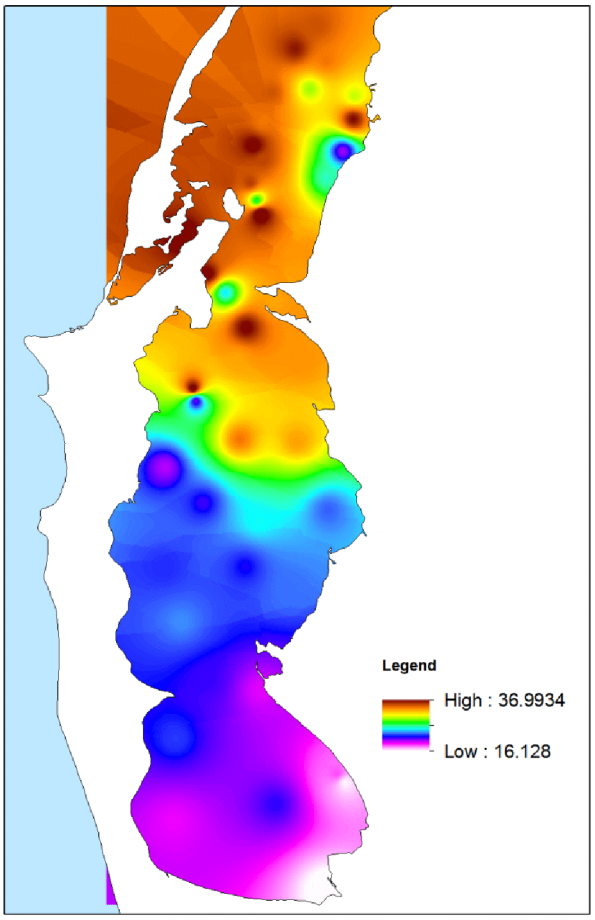


Fig.1. Salinity variation of the Puttalam lagoon in 2016

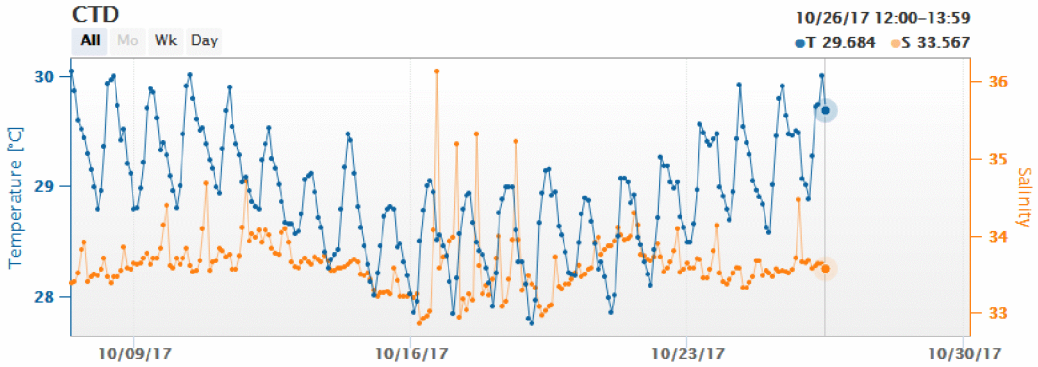


Fig.2. Routine monitoring of water quality parameters in selected sites, Uchchamunei

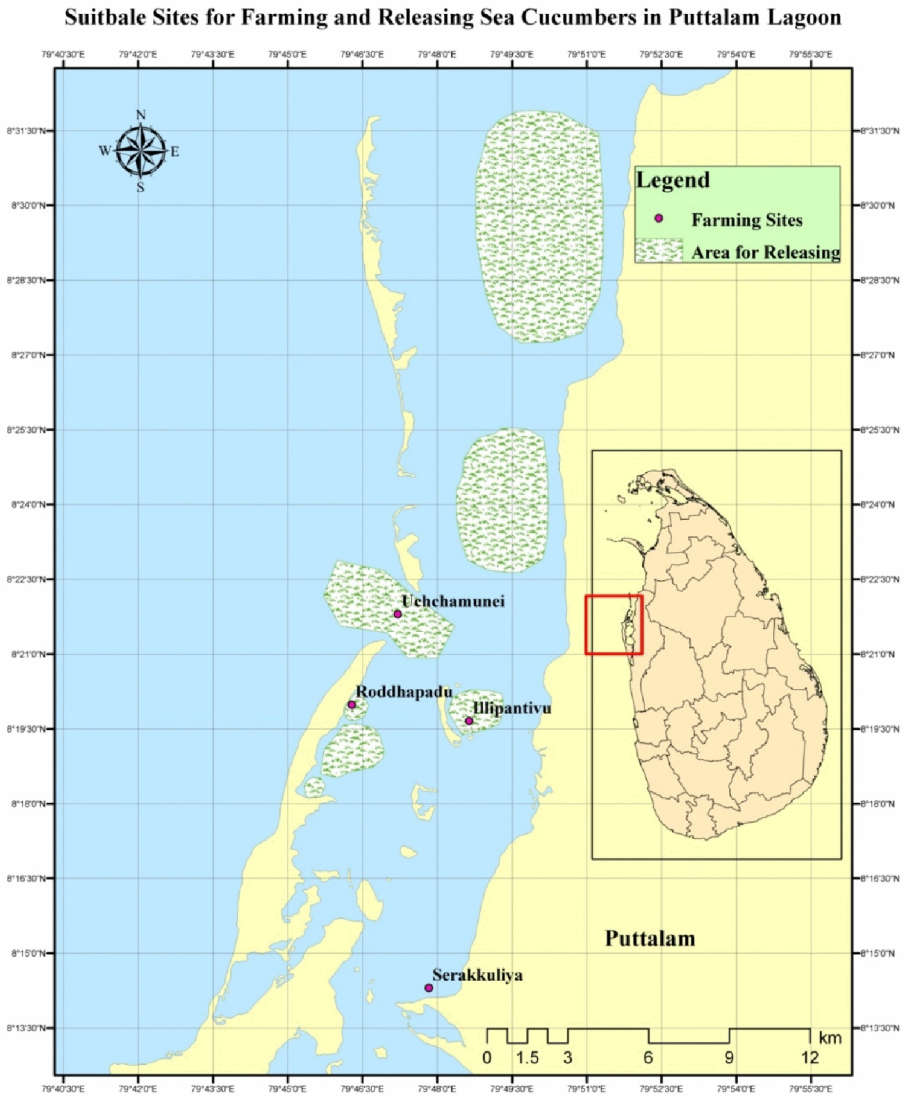


Fig.3. Suitable sites for releasing sea cucumber juveniles and selected sites for community-based sea cucumber farming in Puttalam lagoon

Training & Awareness Programs

Three awareness and *in situ* training programmes were conducted for Community-based Fisheries Organizations (CBFO's) in Rodhapadu, Illipantivu in Kalpitiya Divisional Secretariat and Serakkuliya in Vanathavilluwa Divisional Secretariat by covering all the aspects of sea cucumber farming (table 1). During the training people were aware on how to avoid issues pertaining to user conflicts and other constraints confront with the industry as experienced in the shrimp farming in the district late 90's. Much of the shrimp farming development has occurred without regulation and due concern for the environment in North western province. Although a few well capitalized farms are properly sited and managed by technically competent staff, a large number of smaller farms find themselves in the opposite situation. There has been loss of mangrove habitat, outbreaks of shrimp diseases and poor production as a result. While development has occurred in the sea cucumber farming in the Northwestern Province implementation of proper management measures should be considered as first priority.

(a). Community-based Sea Cucumber Farming

This pilot project was conducted in Puttalam district covering two Grama Niladhari division called Kalpitiya and Serakkuliya in where the higher percentages of artisanal fishermen are living. 115 members of 3 CBFO's were selected and aware being held half day workshops. They were distributed net mending materials to make 15 m X 15 m size pen enclosure and the pen was constructed with community participation and *in situ* training was given to them for pen preparation and maintenance during the culture period. Three pens were constructed in the selected areas. NARA has been providing technical *know-how* to conduct the farming activities throughout the culture cycle by monitoring growth and water quality parameters. The total culture cycle will be expected for 8-10 months and estimated net revenue to the fishery society through this pilot project is about Rs 200,000.

Table 1: Community-based awareness, training programmes conducted and pen enclosures established sites.

Date	Location	No. of participants	Gender (Male: Female ratio)
04.04.2017	Roddhapadu	40	1:1
06.08.2017	Serakkuliya	40	2:1
07.08.2017	Illipantivu	35	1:1

(b). For University Students

A demonstration breeding trial was performed for under graduate students from University of Sri Jayewardenepura and University College of Anuradhapura on 06th of August 2017. Combination of dry, high pressure water jet and thermal treatment methods were used for induce breeding. Students were given first hand on experience in brooders handling, induce breeding, spawning behaviour, larval tank preparation in sea cucumber seed production.

Artificial seed production and larval rearing

60 No's brooders purchased from the project fund and still being conditioning at NARA Regional Center, Kalpitiya. 18 breeding trials were performed from March to November 2017. After breeding weak and low weight brooders were sorted out and put in to lagoon pen for further conditioning. Larval rearing is being carrying out with different formulated feed. Chemicals were acquired to marking juveniles and water quality monitoring. Live feed cultures were maintained successfully. Formulated feed was prepared for brooders to enhance breeding performance and being tested presently. Routine monitoring was carried out in grow-out farming activities in Uchchamunei area until August 2017.

Table 2: Breeding schedule, no. of brooders, salinity and breeding techniques adopted during the period:

No	Month/Date	No. of brooders	Salinity (ppt)	Breeding method	Result
1	13.03.2017	48	33	Cold & hot	
2	25.04.2017	54	33	Cold shock	Two males were spawned
3	26.04.2017	70	33	Cold & hot	
4	31.05.2017	35	34	Cold & hot	
5	01.06.2017	42	34	Cold and algae paste	
6	22.06.2017	36	35	Cold	
7	07.07.2017	45	36	Cold & hot	
8	08.07.2017	33	36	Cold and algae paste	
9	09.07.2017	27	36	Cold and algae paste	
10	06.08.2017	38	38	High pressure water jet & cold	
11	-Do-	31	38	Hot shock	
12	07.08.2017	58	38	Dried method, high pressure water jet, *Spirulina* bath	
13	September	No	No	No	
14	05.10.2017	77	40	Combination method	
15	02.11.2017	27	40	Cold & hot	Male spawned
16	-Do-	26	40	Hot	
17	-Do-	26	40	Cold & hot	
18	03.11.2017	72	40	Cold & hot	

600 no's larvae (~1g) purchased from the outside hatchery. Then, larvae are being reared in hapas until juvenile stage (2-5g) before stocking in pen enclosures for 30-45 days. Marking experiments will be done before wild releasing

Monitoring of commercial sea cucumber farming in Northern area

There are around 40 pen sites which the size range from 1 to 4ha scattered in the Mannar, Killinochchi and Jaffna districts. They were distributed from 1m to 3.5m depth range. Wild captured sand fish juveniles (50-100g) are introduced into these pens throughout the year and reared up to 8-12 month period then partially harvested. During the field observation outside the pen areas we were unable to find none of individual below 30 g in size.

Progress: Physical : 85 % Financial : 98%

Outputs:

- Built up awareness in fishing communities on sea cucumber farming
- Trained fisher-folks on community-based sea cucumber farming
- Identified the importance of sea cucumber farming as a fisher-women empowerment method
- Tested results of the integration of different kind of breeding methods
- Feed formula for brooders which can be prepared with locally available ingredients
- Disseminated technical *know-how* preparing scientific publications and supervising under graduate students.
- Site selection map for sea cucumber farming/culture
- Observed and clearly evidence to prove absence of small size juveniles around commercial pen sites
- Possibility of incorporate oceanic data in aquaculture development

Outcomes:

- Capacity building of fisher communities on alternative livelihoods.
- Identification of suitable sites for sea cucumber farming and natural releasing in Puttalam lagoon Non-responses of induce breeding methods under harsh environmental conditions or climatic changes

Constraints:

Although 18 breeding trials were performed during the period none of succeeded. When monitor the water temperature in the brooders holding tanks it varied between 29.0^{o} C -36.0^{o} C daily. As they were naturally stressed due to diurnal temperature fluctuation thermal induction did not work. These unfavourable weather conditions in the area and also some biological reasons may caused to continuous failures of breeding trials. However, two and one male induced and released sperms in the breeding trials carried out in April and November respectively but non- female followed. Although a semi-shed building was constructed to shading the brooder holding area it existed only two week. By introducing zonal plan for open water mariculture farming can avoid many of the problems that arise with the artisanal fishermen in the area regarding resource sharing, boat navigation and access to landing sites etc.

PROJECT NO : 1.8

DEVELOPMENT OF COMMUNITY BASED OYSTER AND MUSSELS CULTURE IN PUTTALAM LAGOON.

Responsible officers : Mr. C.B. Medagedara

Mr. H. Galahitigama

Mrs. S. Corea

Objectives:

- Increase the commercial bivalve culture among low income fisher communities
- To provide economic benefits to the farming societies by aiding community-based culture programs.
- To start mussels culture and study the growth performances.
- To improve oyster culture techniques.
- Disseminate technical knowhow among oyster farmers.
- Study on seasonal clam fishery in Puttalam lagoon.

Project background/ Introduction:

Edible bivalve culture is most popular in worldwide, and oysters are commonly consumed in raw or cooked. Bivalves are excellent source of Zinc, Iron, Calcium and Selenium as well as Vitamin A and Vitamin B12 and rich in protein. Bivalve resources have been reported to be considerable in the coastal waters of Sri Lanka, bivalve culture is still at the experimental stage. The National Aquatic Resources Agency (NARA) is the main governmental agency involved in the applied research of mollusc culture in the country.

Based on the past experience community based pilot projects were launched in three places in Puttalam lagoon. while continues monitoring was carried out to determine spat availability and water quality condition variations. Ultimately it was found that some of the areas are suitable for the commercial culture while other locations could be used for the spat collection. Mussels are very popular bivalve species among tourists. Past studies have shown that mussels culture can be performed well in Puttalam lagoon when the salinity level is high. Clam fishery is another popular fishery among the local fishers. Community based oyster viz. *Crassostrea madrasensis* culture development and pilot study on mussels culture folks during off season period in Puttalam lagoon.

Activities carried out:

- New culture sites were found for expansion of the commercial culture and expand oyster culture project by connecting possible fisher families around Kalpitiya area
- Developed facilities for stocking of mussels and oyster spats
- Monitored growth and water quality parameters
- Conducted awareness programs for fisher-folks
- Improved capacity and hygienic condition of depuration plant
- New spat attachment materials were innovated to improve spat collection

Results:

New culture sites for expansion of the commercial culture and expand oyster culture project by connecting possible fisher families around Kalpitiya area. Based on the studies community based pilot scale projects were launched in 03 places at Puttalam lagoon including Kandakuliya, Anawasala and Janasavipurawhile continues monitoring was carried out to determine spat availability and water quality condition variations. The project was designed to improve community based oyster (*Crassostreamadrasensis*) culture. According to the results in previous years' continuous research kandakuliya culture site was selected as commercial culture site. In 2016 *Prajasanwardana-kantha -samitiya* in Kandakuliya produced nearly 7000 raw oysters for market. Water quality parameters were found to be ideal for community based farming practice.

Janasavipura located two kilometers away from the Kalpitiya found to be a very much suitable oyster farming area because of the ideal water quality parameters, well established women society "Dhiriya Dheewara kantha samithiya" and availability of transportation. The culture site was designed to be located 50m away from the local landing site and place was 1 -1.5m depth with eel grass covered muddy floor which was easy to establish rack structures. There were 10 racks already prepared for each member of the society and stocked 800 – 1000 juvenile spats on each racks. Culture bags also designed by themselves after several training programs conducted by technical staff of NARA. Committee members of the relevant society actively participated for monthly cleaning procedures and vowing of culture structures for future use.

Third culture site had been identified in Anawasala area which was a best experimental culture site for oysters. A women society called "Diriya kantha karya samitiya" was established by selected 10 number of fisher women in the village. Same procedure was followed to establish oyster racks in the lagoon, selected place was 2m depth and suitable for rack preparation. Due to the possible depth of the place NARA technical staff introduced them long square shaped woven net structure rather than round shaped cylindrical structure. Members of the society actively participated for the monthly cleaning process and oyster spat stocking sessions conducted by NARA staff.

Economic and social background of the villages

Lagoon area prevails right around the villages therefore their main livelihood income source was capture fishery. Population of the village consists on low income and medium income fisher communities. Apart from fishery they engaged on dry fish production, Fisher women in the village engage in seasonal clam and cockle collection, fishing net sewing and labour works in the small landing sites. Sinhala, Tamil and Muslim families lives peacefully

Current status of the infrastructure facilities of the villages

Conditions of the roads inside the village and main road from the Kalpitiya to AnawasalaandJanasavipura were not good. Gravel and sandy roads get worse during the rainy season. Due to lack of proper drainage lines water stagnate on the roads. Drinking water problem is a main burning issue for them because they don't have clean wells or tube wells to obtain water. They buy water from outside vendors for drinking purpose. Fishermen wants properly designed landing site for their fishing activities.

Participatory Rural Appraisal

[PRA] was carried out with the participation of the members of women societies in selected villages. Thirty members participated in this appraisal. All the participants actively participated and developed village resources map and social map. The group identified one of the main resources of their village is the lagoon. Some women were already engaged in collecting shellfish from the lagoon. It was revealed that women of the society were willing to start oyster culture as a livelihood activity with necessary training. The community based oyster farming empowering the marginalized low income fisher women by aquaculture self-employment.

Non-traditional oyster culture has a good potential to become a farming venture to uplift the socio economic status of small scale fisher families and strengthen the fisher women in the village. That should lead the saving of money in their pockets. Two social mobilization training programmes were conducted with the participation of 20 women.

Preparation of facilities and stocking of mussels and oyster spats

Stocking of oyster spats and mussels spats always a challenge during initial stage of the project because proper culture structure needed for entire life time of the juvenile to adult. It should be much strength to hold 30-40 adult oysters during 1 -2 years, easy to handle by especially fisher women, should be easy to wove by women and much more easy to clean using brush. In the 2017 project year NARA had been designed several culture structures during training sessions and fisher women had trained to made their own culture baskets by themselves. Those designed cultures structures were cost effective and can be made using locally available nets, PVC and nylon materials. Most of the culture structures can be effectively used for oyster and mussels culture both and especially mussel's structures made using small eye plastic nets due to the rather small in body shape than oysters.

Oyster spat attachment preparation

Prepared novel oyster spat collector which is easy to detach spats without causing any physical damage to immature stages. It was designed to increase surface area because previously used low surface area attachments were not much effective regarding collection of spats.

Raw materials

- 1" wooden shafts (reaps)
- 28 parts of 30cm long 2" half irrigation PVC pipes
- 4mm nylon ropes

It is easy to suspend or hang on wooden poles. Spats will remove by tapping PVC halves against rough surface or each other. Estimated production cost per collector is Rs 200.00



plate 1. PVC plate oyster spat collector (Upper and side views)

Possible drawback of this attachment is weight and wooden frame. The frame made using metal nails but the problem is, it will cause rust and frame will collapse. Therefore, again attachment developed using PVC tubes instead of wooden reaps. It is low weight and suspended better than previous one. Surface area also increased with PVC tubes.



Plate 2. Plastic casing structure spat collector

Prepared novel oyster spat collector which is easy to detach spats without causing any physical damage to immature stages. It was designed to increase surface area and purpose of introducing suitable material for longer usage. Plastic electronic wire casings were found from renovation site of NARA head office.

Raw materials

- 2" Plastic casings
- ½" Casings
- 6 parts of 30cm long 2" half plastic casings
- 4mm nylon ropes

It is easy to suspend or hang on wooden poles. Spats will remove by tapping PVC halves against rough surface or each other. Estimated production cost per collector is Rs 200.00. White surface increases the visibility of small spats during immature stage.

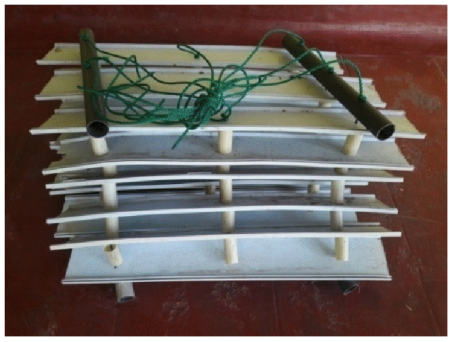



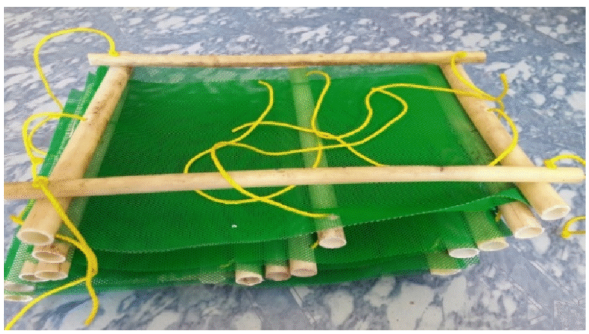
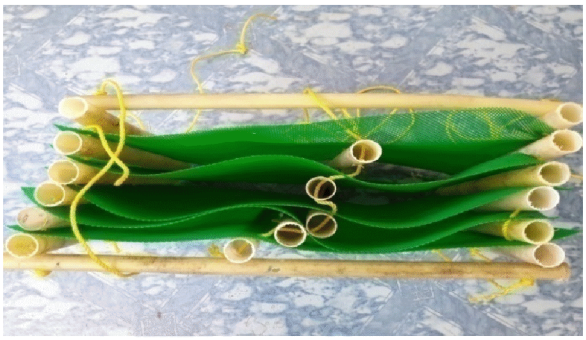
Plate3 PVC conduit reinforced flexible net spat collector

Prepared novel oyster spat collector which is easy to detach spats without causing any physical damage to immature stages. It was designed to increase surface area and purpose of introducing suitable material for longer usage. Flexible net structure easy to submerged and water pass through it nicely. This attachment is light weight and easy to prepare rather than other two structures.

Raw materials

- Flexible net with tiny eye size
- ½" conduit tubes
- 4mm nylon ropes

Estimated production cost per collector is Rs 100.00. Net surface increase the visibility of small spats during immature stage. Possible drawback of this structure will block tiny holes from silt and mud layers but it makes suitable possible attach ground to oyster spats.

Undergraduate research student of University of Peradeniya has been conducted a research under the guidance of IARAD/RRC Kalpitiya NARA to find out effective attachment material form novel developed three attachment materials. He conducted research at two separate oyster bed locations in Gangewadiya Kalaoys river mouth. He used three treatments and for each treatment three replicates. Data was recorded twice a week, spat count and physical water parameters were measured.

Spat count variation in location 1.

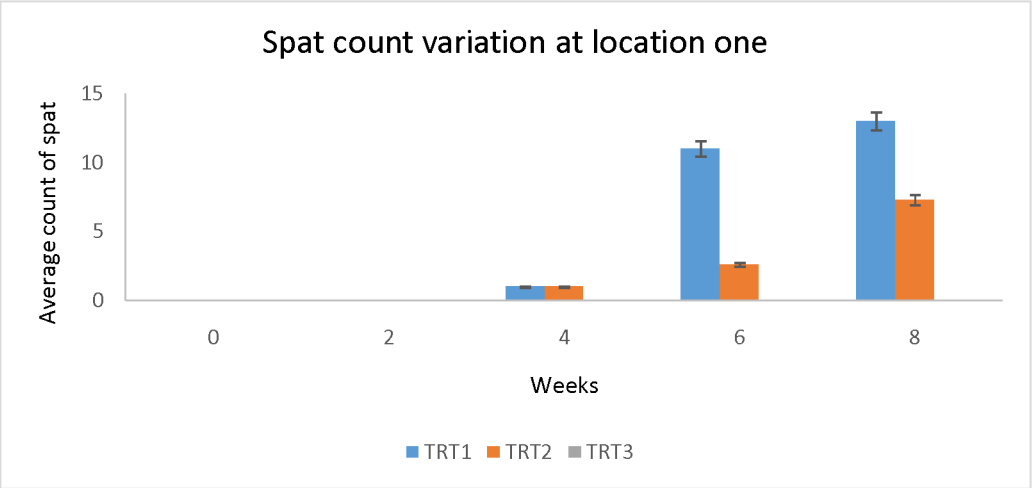
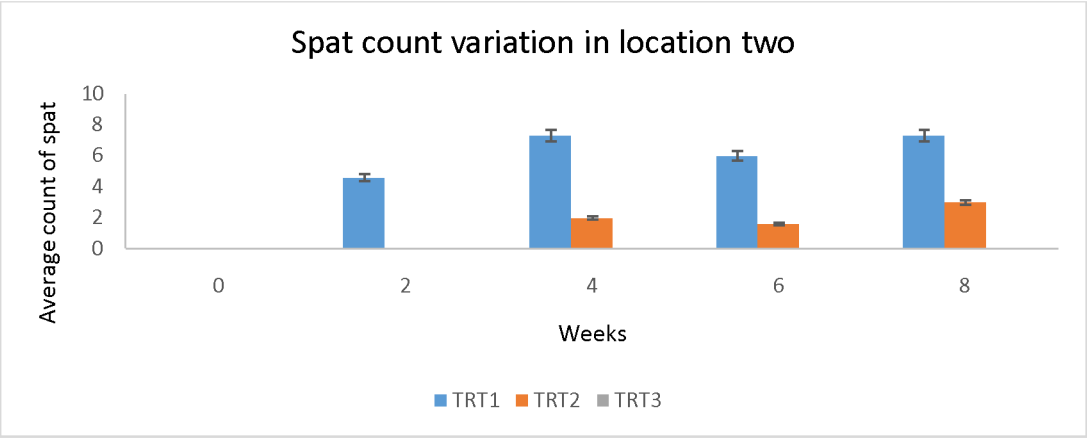


Figure 1 Spat count variation in location (key: TRI

Average value represents the mean ± standard error.

According to the figure during the first two weeks, no any count recorded in all treatment in the location 1. After 2nd week start spat settlement on the collectors. The mean number of oyster spat settlement was higher on the plastic (TRT1) spat collector. Spat on PVC collector (TRT2) lower than plastic collector and no spat settlement recorded on nylon collector (TRT3). So there was a significant difference between the three collectors and spat settlement was significantly higher on plastic spat collector.



Fiure 2 Spat count variation in location 2.

Average value represents the mean ± standard error.

According to the figure during the first week, no any count recorded in all treatment in the location two. After 2nd week start spat settlement on the collectors. The mean number of oyster spat settlement was higher on the plastic (TRT1) spat collector. Spat on PVC collector (TRT2) lower than plastic collector and no spat settlement recorded on nylon collector (TRT3). So there was a significant difference between the three collectors and spat settlement was significantly higher on plastic spat collector.

Other oyster attachment materials and deploy in collection grounds.





















Novel spat attachment materials and traditional spat attachment materials hanged in Kumburawa / Gangewadiya natural oyster beds.

Oyster spat attachments types and hanging of finished spat collectors

Naturally available oyster shells, Coconut shells, roof tiles, asbestos sheets and fiber sheets used to prepare traditional oyster spat attachment clusters. The identified problems regarding this type of materials are the low surface area and roughness of the surface. Actually low surface areas reduce the chance of attaching free flowing spats. Roughness of the surface affect when spat mechanically detach from the adhered surface. Asbestos sheets are not environment friendly and fiber sheets are not cost effective. Therefore, PVC attachment material is more suitable as oyster attachment material. It is easy to prepare and easy to hang on wooden poles.

After received annual monsoonal rain to kalpitiya, we deployed prepared materials with the intention of collect spats from natural oyster beds. According to the monthly water sampling results, it has been observed that some D shape free swimming juvenile stages present in water samples.

Table1 : Spat attachment details in different materials

Type of attachment	Amount of attachments used
PVC attachments	40
Electrical casing box structures	40
PVC conduit reinforced flexible net spat collector	20
Coconut shells	300 strings
Asbestose roofing sheets	100 strings
Oyster shells	100 strings
Fiber sheets	100 strings
Tile	100 strings

Novel attachments successfully hanged on newly made oyster racks, beside naturally grown heap of oyster beds. Other traditional materials may have hanged on mangrove twigs and roots. Due to the low water flow with comparing of the left bank of river right bank was selected for experimental work. Undergraduate

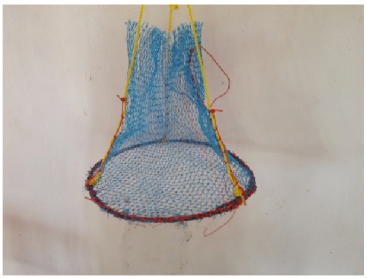
Research student of University of Peradeniya, conducted a research work to find the most effective oyster spat attachment material among three novel developed attachments.

Find out the most suitable culture structure for mussels farming

Designed three culture structures of same internal surface area to asses growth parameters (Length and width) of brown mussels (*Perna perna*)



(1)



(2)



(3)

1.) Plastic control type box structure
2.) Round pouch made by flexible net
3.) Round pouch made by hard type net

From each type made three replicates and stocked twenty mussels spats for each. This growth experiment was started in July 2017. Selected sites were Janasavipura and Anawasala. Average size of stocked mussels spats were (47.45±1.63mm length and 23.1± 1.37mm width). Through this scientific experiment we would like to get an idea for suitable culture structure for commercial culture of *Pernaperna* in Puttalam estuary which is not available in naturally. The first load of brown mussels spats we had taken from Negombo lagoon as per the experimental purpose.

Best growth showed in round pouch made by hard type net it was 6mm length increase per month. This hard type net structure was a rigid structure and withstand for rough water and difficult to damage by fish. It was easy to clean and did not block due to debris on net. The round pouch made by flexible net showed 5mm length increase per month. The main inconvenience faced during experimental period was rabbit fish *(Siganus javus)* ate debris covered flexible strings and cause damage to structure. The main advantages were light weight and easy to handle. The plastic control type box structure was always blocked its small pores by debris and water circulation was blocked with time. It showed 3mm length increase per month. According to the applied experiment it was recommend using round pouch made by hard type net for mussel's culture in Puttalam lagoon.

Table 2 Monthly data recording was conducted in below test sites

Site	Status
Anawasala	Oyster - Round cage Mussels – Round / Plastic cage
Janasavipura	Mussels – Round / Plastic cage
Kalpitiya	Oyster - Round cage / Plastic cage Mussels – Round / Plastic cage
Eramutive	Mussels – Round / Plastic cage
Gangewadiya station 01	Oyster - Round cage / Plastic cage





Measure oysters and mussels

Site	Mean	Range
Anawasala	33.09±3.83	28-40
Janasavipura	33.82± 3.63	28-40
Eramathive	34 ±3.26	30-40
Gagewadiya(G1)	20 ±9.47	2-34
Gagewadiya(G2)	25.56± 8.37	4-34
Gagewadiya(G3)	27.95± 5.83	20-36
Gagewadiya(G4)	29.7± 5.13	20-34
Kalpitiya	33.73 ±3.69	28-40

Site	Mean	Range
Anawasala	107.27±14.89	85-130
Janasavipura	118.18±21.48	80-150
Eramathive	114.09±9.17	100-135
Gagewadiya(G1)	113.18±8.74	105-125
Gagewadiya(G2)	100.45±11.06	85-125
Gagewadiya(G3)	122.73±16.18	90-145
Gagewadiya(G4)	128.18±17.79	100-140
Kalpitiya	129.55±15.57	100-150

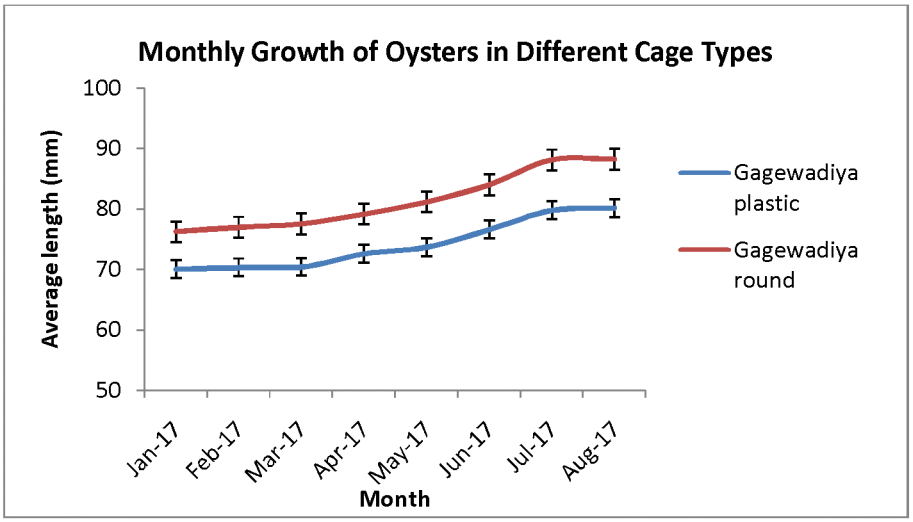
Table 3 Water quality parameters measured at frequent intervals Salinity Variation at different sites



Cleaning of culture structures



Packed culture oysters



Monthly growth of oysters in different cage types

Study about seasonal clams' fishery to quantify natural harvesting, processing and marketing



Marcia opima and Marciahiantina



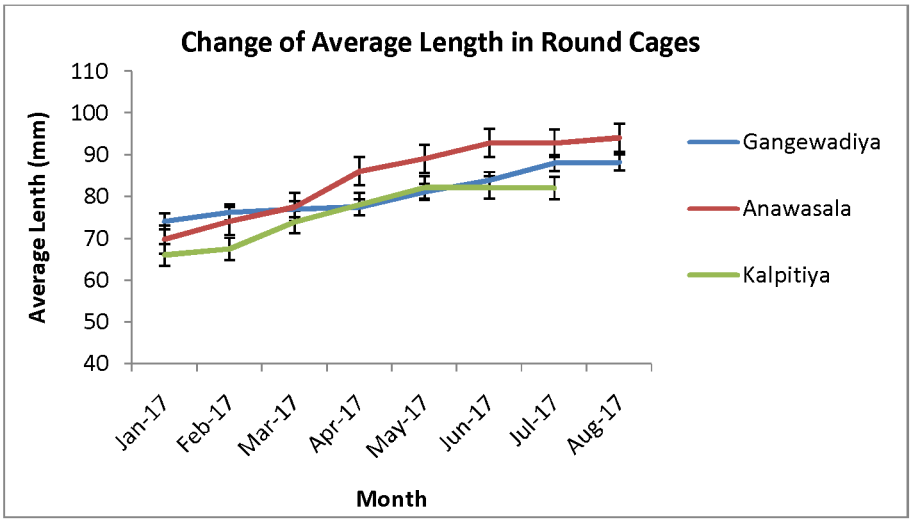
Grafrarium tumidum



Mixing of salt with boiled clams



Finished product for market



Currently there are two places in Kalpitiya area carry on this seasonal clams fishery by local fisher women. The main two shallow lagoon areas where follow this fishery was Mattikalama and Pichchnkalli. It was a marginal fishery which followed by two main fishermen with supporting women.Rs 400/=wholesale price was for1 Kg of finished product. This fishery was confined to off season (South west monsoon period) because low tide level goes more and it creates a bear ground for excavate clams and cockles

Processing and marketing procedure

- Most of the time per day time each woman excavate nearly 2 ½ - 3 ½ Kg of raw clams so each group caught nearly 40 to 50 Kg per day.
- Then in the evening they boil those clams with lagoon water for ½ an hour for easiness to peel off bivalves.
- After that collect boiled meat and sold to buyer woman for about Rs 300/= per 1Kg who prepared sun dried clams for local dry fish market.
- Then salt added for boiled meat as 1 Kg of salt for 5Kg of wet meat and then stored one night in closed container.
- During the sun dried process weight reduced by half of the full weight
- Following morning sun dried until noon and stored in open containers until release to market. Farm gate price per 1Kg, Rs 650/= and Retail price was Rs 700/=
- Now there were not proper market for peeled off bivalves and heaps of shells can be seen in boiling places.
- Those fisher groups did not go to excavation nearly ten days during the month
- For year 2017 they started collection in May and finished in October because North East monsoon started at the mid of the October.
- Improved capacity and hygienic condition of depuration plant

The total revenue earned by the NARA RRC Kalpitiya by operating the Depuration plant in year 2017

Date	Number of Oysters	Depuration cost per oyster	Total revenue	Bill Number
26/01/2017	560	5.00	560x5.00 = 2800 560x25.00=14000 16800.00	026017
16/03/2017	642	5.00	3210.00	026643
24/03/2017	587	5.00	2935.00	026643
05/07/2017	618	5.00	3090.00	027176
17/08/2017	55	5.00	55x5.00 = 275.00 55x25.00= 1375.00 1650.00	027571
16/09/2017	605	5.00	3025.00	027897
12/10/2017	504	5.00	2520.00	028460
26/10/2017	505	5.00	2525.00	028689
08- 10/12/2017 Sea Food Festival	300	50.00	15,000.00	
15/12/2017	578	5.00	2890.00	029103
22/12/2017	970	5.00	4850.00	
22/12/2017	300 (Sold)	20.00	6000.00	
UP to Total	5924		64,495.00	

During the Colombo sea food festival time we sold depurated grilled oysters approximately 300 for 50/= each and earned nearly Rs 15,000/=. Those oysters were cultivated in RRC Klapitiya oyster racks.

Total revenue earned by three community based oyster farming societies2017

Name of the society	Farm location	No of sold oysters	Total revenue earned (Rs)
Diriya Dheewarakanthasamithiya	Janasavipura	2320	46,400.00
DiriyaKanthaKaryasamithiya	Anawasala	504	10,080.00
PrajaSanwardanaSamitiya	Kandakuliya	3100	62,000.00
Total		5924	118,480.00





Oyster culture, Mussles culture and seasonal clam's fishery training programs for Fisher folks, University undergraduates and UNIVOTEC students





Group meetings with community based farmers

We conducted awareness programs for community based farming groups in Janasavipura and Anawasala. In that sessions disseminated knowledge on oyster farming technology, culture structures production, oyster attachment materials preparation, Hygiene and depuration process and marketing aspects. All the farmers actively participated that sessions held on their farming places.







Demonstrations for undergraduates and UNIVOTEC students

Undergraduates of University of Sri Jayawadanapura and students in UNIVOTEC, Anuradhapura also accompanied for bivalve culture training sessions. They received hands on experience regarding bivalve culture, oyster farming, mussels culture and seasonal clam and cockles' fishery, at the end we provided sufficient knowledge regarding oyster depuration procedure and product development aspects.

Progress: Physical : 85% Financial: 100%

Output:

- Built up awareness among fishing communities, university students and governmental officials on community based oyster farming and potential of culturing brown mussels and identify study harvesting and processing of clams prevails in the Puttalam estuary.
- Trained fisher-folks on community-based oyster farming aspects, spat collection, culture structure preparation, cleaning and hygienically end product preparation
- Preparation of facilities and stocking of mussels and oyster spats (Developed three novel oyster attachments and four kinds of oyster culture structures)
- Study on seasonal clams fishery for identify potential to using of processed clams for product development and year round availability.
- Improved capacity and hygienic condition of depuration plant and supply quality end product for valuable customers throughout the year.

Outcome:

Oyster culturing is an appropriate alternative for livelihood development. Oyster culture basically depends on spat availability and environmental conditions. For spat collection we can use diverse spat collectors. Here different types of spat collectors enhance the spat availability as well as spat survivability for commercial production. Availability of spat highly related with environmental conditions especially salinity level in water. Higher salinity fluctuations would have created growth reduction of oysters. Simultaneously using of different types of oyster cages has an effect on oyster and mussels growing.

In this project it was identified that community based oyster farming is increasingly advocated as such an alternative that are readily accepted by coastal communities. Present fisher folks want to expand their culture to supply even quantity during the whole year and increase revenue for better life.

Recommendation:

- Community based oyster farming was popular among fisher folks during past two years and more people wants to culture oysters as their livelihood. Spat availability and collection is the main issue for expansion and natural spat collection methods should develop in future.
- According to the results the best structure for mussel growing is round pouch made by hard type net and best spat collector for oyster culturing is plastic spat collector. Therefore these structures are recommended for commercial oyster culturing. However,for commercial level oyster culture it is necessary to modify these spat collectors in future.
- Gagewadiya, Anawasala and Janaswipura areas are better for both oyster and mussel growing.
- The water conditions prevail in these areas ensures the sustainable production in future. Therefore several community based oyster culture projects should initiate in future under the supervision of NARA and Ministry of Fisheries and Aquatic Resource Development.
- As the aim of mass production of oysters; commercial level hatchery should be established in future to obtain quality seeds for commercial farming. Concurrently the market facilities should enlarge especially targeting of foreign countries.

Constraints:

Climatic changes acted as the major killing factor in this year due to prolong dry period in most productive months viz. May to November resulted reduced spat falling. After the Northeast monsoon, Kala Oya received rainy water, which act as natural stimulation for oyster breeding and spat falling. Spilling of perennial and seasonal tanks in the two provinces brought heavy load of water drained in Mee Oya and Kala Oya and emptied to Puttalam lagoon. As we promote commercial oyster farming for fisher women societies, they managed to find some spats. We received more orders from oyster buyers but the problem is continuous supply due to lack of natural spats for batch wise culture. Therefore, it is recommended for establish oyster hatchery in Kudawa to supply enough spats throughout the year and stop depending on natural reserves. Farm gate price for mature oyster varies from Rs 20.00 to Rs 22.00, but the society people wants to increase price more. Due to low price some members of the Anawasala society may left form the community based farming project.

PROJECT NO : 1.10

SURVEILLANCE AND DEVELOPMENT OF SCREENING METHODS FOR DISEASE CONDITIONS IN ORNAMENTAL FISH INDUSTRY IN THREE SELECTED DISTRICTS.

Responsible officers : Dr. (Mrs) A.D.W.R. Rajapakshe

Objectives:

- To recognize disease conditions among ornamental fish species.
- Build aware of farmers for disease conditions and improve the remedial measures and therapy.

Project background/ Introduction:

Diseases are, one of the major constrains for the development of Ornamental fish industry. Many disease conditions are prevail in Ornamental fish sector and cause significant losses .This project mainly targeted on the close monitoring & development of screening methods for parasitic and bacterial disease condition in selected 15 farms in Gampaha, Kaluthara & Galle districts.

Activities carried out:

- Each farm was monthly monitored for disease conditions and selected water quality parameters.
- Disease samples were analyzed in situ and other samples were brought to the laboratory for further analysis.
- Tested water parameters were Dissolve Oxygen content, pH, Air & Water Temperature, Alkalinity, Hardness, Ammonia, Nitrate, Nitrite & Phosphate.
- Collected details on the feed and feeding, sanitation etc. in each farm.

Results:

Table 1: Locations of the farm studied in each district

Gampaha district	Kaluthara district	Galle district
Kadawatha	Bandaragama	Batapola
Delgoda	Do	Karandeniya
Indigolla	Do	Baddegama
Ja-ela	Aluthgama	Ambalangoda
Bopitiya	Moronthdwa	Galle

Table 2: Ranges of the water quality parameters in visited farms from March to November2017 in each district.

District	pH	DO (mg/l)	Water temp. (C°)	Air temp. (C°)	NH_3 (mg/l)	NO_2 (mg/l)	NO_3 (mg/l)	PO_4 (mg/l)	Alk. (mg/l)	Hard. (mg/l)
Gampaha	6.12-7.8	1.95-6.09	25.2-29.7	25-31.9	0.09- 4	0.006-.74	0.1-5.7	5.2-over	11-23	10-62.8
Kaluthara	6.48-9.58	3.2-13.6	24.6-31.9	24.1-30.1	0.1-1.11	0.001-.303	0.01-13.5	0.04-1.75	2.4-29	11-98
Galle	6.37-8.61	2.75-9.4	24.6-28.9	24.6-31.2	0.01-0.04	0.004-.04	0.01-0.114	0.2-4.71	2.8-15	27-132

Table 3: prevalence of disease condition out of 5 farms in each district from April to November 2017.

District	Pathogen	April	May	June	July	Aug.	Sep.	Oct.	Nov.
Gampaha	Gill/Skin flukes	1	2	2	1	3	2		
	Trichodina	1				3	1		
	Bacterialfin rot/Wonds,dropsy	1	1			1	1	1	
	Oodinim		1		1				1
	Chilodonella							1	
	White spot				1				

Galle	Gill/Skin flkes				1	1			
	Trichodina		1		1	2			
	White spot				1	1			
	Unknown disease for angles			1		1			
Kaluthara	Gill/Skin flukes				1				
	Trichodina	2			2				
	Bacterial fin rot/Wounds, dropsy							1	
	Anchor worm		1						

Higher intensity of prevailing diseases was Gill/skin flukes and *Trichodina* infections in all districts. (Table 3). Low pH levels (6.12- 6.5) due to rainy conditions, high levels of Ammonia (>0.025mg/l), Nitrite (>0.1mg/l) and Nitrate(>5mg/l) were identified as causative factors for the increase of disease causing pathogens in Gampaha district.(Table-2). Less water changes and high stoking densities for live bearers, and fighters (more than 5fish/ feet^2) also identified as causative factors for disease prevalence.

Pathogens mostly affected in July and August months (Table-3) and mainly affected fish were guppy, sward tail, platy and fighter fish in each district.

Progress: Physical : 90% Financial : 90%

Output:
Healthy & good quality Fish for the export market.

Outcome:
Knowledgeable farmers with identification of fish disease conditions, remedial measures & therapy.

Constraints:
Unable to visit some farms due to flood condition in Galle and Kalutara districts.

PROJECT NO : 1.12

FISH FEED DEVELOPMENT AND ORNAMENTAL FISH PRODUCTION PROGRAM AT PANAPITIYA REGIONAL RESEARCH CENTRE.

Responsible officers : Mr. G.S.C. Perera

Mr. E.D.M. Epasinghe

Objectives:

Component 01

- To introduce rational feed formulas satisfying the nutritional and colour enhancing requirements of the specific stages and also the specific species of the ornamental fish in order to fulfill the requirements of the ornamental fish exporting conditions.
- To introduce fish meal replacements.
- To transfer technical know-how and identified formulas for provincial and small scale fish feed producers and empower them towards rational and sustainable local feed industry.
- Income generate from fish feed selling and introducing the above fish feeds as an alternative to the imported feeds.

Component 02

- To supply Koi carp, Angel and Gold Fish seeds and brooders for the farmers .
- Income generation through selling the seeds, brooders and excess grow out.
- To maintain quality Koi carp brood stock.

Project background/ Introduction:

There are identified issues in ornamental fish industry and lack of enough seeds, disease outbreaks, lack of proper brooders and the issues related to feeds are among them. Here, the last point feeding is addressed. At present few farmers prepare their own feeds. But we came to know that most of feed producing farmers are not having sound knowledge on feeding and nutritional requirement of the applicable fish. Most of farmers prefer to buy higher protein diets and they use shrimp feeds and Seabass feed and also the feeds prepared for food fish regardless of the species and stages of the fish. Though the better growth performance could be achieved with feeds some other key points that are important in ornamental fish exporting such as body shape and colour enhance cannot be achieved. Therefore, our aim was to introduce stage specific feeds (nursery, grower, brooder) and species specific feeds, which touch the nutritional requirements of each species. Here not only the growth performance but also the better pigmentation is targeted adding suitable colour enhancers.

Producing and supplying quality improved KOI Carps, Angel Fish and Gold Fish seeds and brooders for the farmers.

As mentioned above many people are engaged in ornamental fish industry, most of them are small scale farmers and they have no special requirements to maintain proper brooders. So they purchase the seeds from other breeders and fingerlings are rearing in their limited cement tanks or mud

ponds. But one of the issues they face is insufficient supply of the seeds on time. Here, we planned to maximize seed production through induced breeding in order to mitigate the identified issue. In addition to that most of the above small scale breeders have not got enough backups for breeding purposes due to the lack of space. So our another aim was to produce some quality fish that can use as brooders.

Activities carried out:

Component 1

- Purchased the required Chemicals, and equipment.
- Procurement of fish feed ingredients
- Produced stage specific feed.
- Proximate analysis.
- Conducted feeding trials at the center and the field.
- Revised the feeds formulas observing the results and feedbacks.
- Produced species specific feed and fish meal replacing feeds.
- Prepared formula and educated the farmers.
- Supplied the feed.

Activities

Component 2

- Purchased required chemicals, and equipment.
- Prepared the pond, Fish breeding, Fish stocking, Fish harvesting
- Selling the fish and keeping the suitable fish for backup.

Results:

- Commercial feed development
- Three stage specific feeds were produced using extruder.

I. Nursery feed

The above feed designed for the nursery stage of ornamental fish and crude protein level at 45%. It is available for sale Rs. 200.00 per one kilogram.

II. Extruded pellet (02 mm)

This feed is designed for the early grower stage and its crude protein level is 38%- 40% and available for sale Rs. 175.00 per one kilogram.

III. Extruded pellet (05 mm)

This feed is designed for the later grower and brooder stages and its crude protein level is 38%-40% and available for sale Rs. 175.00 per one kilogram.

All the above extruded pellets are floatable and first those feeds were used by Panapitiya Center and NARA head office and then all the feeds were sold to the farmers and considering their feed backs all the feeds were re developed.

Total production for the year 2017 was 2313.75 Kg and it can be categorized as follows:

Mode	Production (Kg)
Sold to farmers	1611.00
Used by head office	162.75
Used by Panapitiya Center	540.00
Total Production	2313.75

Total income gained by selling of fish feeds were Rs 268,149.50.

Research activities related to fish feed

- In order to minimize the production cost, the following fish meal replacement trials were conducted.
- Fish meal replacement with soya with best replacing percentage was identified as 35 %
- Fish meal replacement by plant protein with best replacing percentage was identified as 50 %

Ornamental fish production

Brooder stage of Koi Carp was sold to farmers in order produce better quality fish. In addition to that Koi Carp, Angel Fish and Tin Foil barb were sold as an income generating source. The total income gained was Rs. 249,650.00. Hence, the total income for the year 2017 was Rs. 517,799.50.

Progress: Physical : 92% Financial :

Output:

- Identified economical ornamental fish feed formula.
- Identified stage specific ornamental feed formula.
- Brooders for farmers.

Outcome:

Technical know-how and formula being empowered the provincial feed producers in the future.

Constraints:

- Lack of cabinet drier and a ribbon mixer needed for better quality feed production.
- Lack of special extruder needed to produce smaller pellet feeds for early grower stage.
- Insufficient mud ponds to uplift the production.
- Insufficient work force /Labour to keep on the production and also to keep the center in clean and better condition.

PROJECT NO : 1.13.1

DEVELOPMENT OF FORMULATED FEED FOR SEABASS FINGERLING CULTURE IN LAGOON FLOATING NET CAGES

Responsible officers : Mr. D.A. Athukorala

Mr. R. Weerasinghe

Objectives:

- To develop nutritionally balanced and cost-effective feed for Seabass fingerling culture in lagoon floating net cages
- To develop nutritionally balanced and cost-effective feed for Seabass grow-out culture in lagoon floating net cages
- To compare different formulated fish feeds on growth performance and survival rates of Seabass
- To assess the economic viability of developed feed for Seabass culture in lagoon floating net cages
- To promote community-based Seabass cage culture in lagoons

Project Background/ Introduction:

Asian Seabass culture has been identified as a profitable business due to its high export demand. Asian Sea Bass (*Lates calcarifer*) culture is most popular in South Asian countries such as Thailand, Malaysia, Indonesia, Singapore, Taiwan and Hong Kong. As sufficient brackish water resources, there is a good potential to develop Seabass culture also in Sri Lanka. At present some hatcheries have developed Seabass breeding technology and some farmers are engaged in Seabass farming in Sri Lanka. However, main obstacle for developing this aquaculture practice is lack of low-cost nutritious feeds in the market for Seabass fish. As no appropriate feeds locally available in the market for an affordable price, most of the farmers mainly use trash fish for Seabass culture. Due to the unavailability throughout the year and fail to give good growth rate, trash fish cannot be considered as an ideal feed for profitable Seabass farming. Therefore, development of low-cost, nutritionally balance feeds is very important for the sustainability of Seabass farming in Sri Lanka.This project is aim at the use of locally available ingredients to produce economical but nutritionally balance feeds for Sea Bass cage culture in lagoon.

There were two activities under this project,

Activity 1 - Development of formulated feed for Seabass fingerling culture in lagoon floating net cages in Negombo lagoon (at Munnakkarai)

Activity 2 - Development of formulated feed for community-based Seabass culture in lagoon net cages (at Serakkuliya and Gangewadiya)

Activities carried out:

- Analysis of feed ingredients for proximate composition
- Formulation of formulated feeds for experimental feeding trials of Activity 1
- Purchasing of sea bass fingerlings for experimental trials of Activity 1
- Preparation of experimental formulated feeds for Activity 1
- Experimental feeding trials of Activity 1
- Collection of fish growth data of Activity 1
- Collection of water quality data of study location of Activity 1
- Cleaning/Mending floating net cages of Activity 1
- Data analysis of Activity 1
- Report writing of Activity 1
- Purchasing of required materials for construction of net cages for Activity 2
- Selection of suitable farmers for community-based sea bass feeding trials of Activity 2

Results:

Able to develop feed formula with satisfactory feed conversion ratio (FCR) for Asian Seabass fingerlings culture in floating net cages in lagoons, using locally available ingredients at the cost of 155.65 Rs./kg (Table 1). Survival Rates of fish and water quality of study site is at acceptable levels during the study period for Seabass farming (Table 1 &Table 2). Proximate composition of tested feeds is given in Table 3.

Table 1 feed tested and results

Feed Tested	T1 (Mannar fish meal-based)	T2 (Peliyagoda fish meal-based)	T3 (Imported fish meal-based)	T4 (Commercial Feed)
Survival (%)	96.2	93.7	94.2	91.7
Final weight (g)	146.1	179.2	200.4	186.9
FCR	2.7	1.7	1.4	1.7
Price (Rs./kg)	162.85	155.65	222.60	330.00

Table 2 water quality data of study the location

	NH3 mg l-1	Salinity ppt	pH	DO mg l-1	Temp 0C	NO3 mg l-1	NO2 mg l-1	PO4 mg l-1
Mean	0.016	26.80	7.70	5.18	28.30	0.23	0.04	0.25
±SD	±.019	±1.93	±0.27	±0.73	±1.16	±0.18	±.07	±0.16

Table 3 Proximate composition of tested feeds

	T1 (Mannar fish meal-based)	T2 (Peliyagoda fish meal-based)	T3 (Imported fish meal-based)	T4 (Commercial Feed)
Moisture %	5.0	5.2	6.87	11.0
Protein %	40.2	40.8	40.4	43.0
Fat %	8.0	7.8	10.5	9.5
Ash %	23.7	20.0	16.9	16.0
Fiber %	3.2	2.2	2.3	3.0

Recommendation:

- Perform commercial level experimental trials to assess the developed feed formula under Activity 1 for Seabass fingerling stages.
- Introduce developed feed formula for private sector to produce feed for seabass fingerling stages at commercial level.

Progress: Physical : 60% Financial :

Output:

- Nutritionally balanced economical feed formula for Asian Seabass fingerling culture in floating net cages
- Research Paper (NARA Scientific Sessions)
- A Poster on "Seabass culture in lagoon floating net cages"
- A leaflet on "Seabass culture in lagoon floating net cages"

Outcomes:

- Availability of economical feeds for Asian Seabass fingerling culture in floating net cages in the local market.
- Attraction of people for Asian seabass culture in lagoon floating net cages
- Increased Seabass production

Constraints:

Unable to completed the "Activity 2: Development of formulated feeds for Asian Seabass through community-based Sebass farming in lagoon floating net cages" of the project as planned due to following reasons,

- Delays in purchasing net cage construction materials on time.
- Delays in receiving the list of suitable persons for work with community-based Sebass farming feeding trials of Activity 2 from North Western Provincial Council on time.

However, requested cage construction materials and list of the selected persons by North Western Provincial Council have received later and planned to commence the Activity 2 in 2018 under the project "Evaluation of formulated feeds developed for Asian Seabass through community-based Sebass farming in lagoon floating net cages".

PROJECT NO : 1.13.2

USE OF CHITOSAN AS AN IMMUNOSTIMULANT IN TIGER SHRIMP (*PENEOUS MONODON*) FEEDS TO RESIST VIRAL DISEASES.

Responsible officers : Mr. R. Weeerasinghe

Objectives:

- To find the effects of Chitosan on growth performances.
- To enhance immunity to resist diseases specially WSSV.

Project background/ Introduction:

Sri Lanka is a country involving in large scale intensive shrimp farming. Most of shrimp products are export oriented. The disease WSSV cause severe damage to shrimps and prawns leading to economic lost. White spot syndrome is a viral infection in Penaeid shrimp. The disease is highly lethal, contagious and kills shrimps quickly. Since this disease is caused by a virus, there is no anti-viral treatment for the disease. Chitosan is an amino polysacharide prepared by processing shrimp waste (shell) which involve parcial deacetylation of chitin and second most abundant natural polymer (Puvvada et al 2012). Both chitin and chitosan exerted immunostimulatory effect on common carp (Gopalakannan and Arul, 2006). Immunostimulants can reduce the losses caused by disease in aquaculture; however, they may not be effective against all diseases.

Activities carried out:

Experimental site

A hatchery which accomplished with clean, filtered and treated sea water as well as sound environment for the experiment was selected around Ambakandawila, Chilaw area.

Extraction of chitosan

Shrimp shells were hired from Alpex marine shrimp processing factory, Alakanda, Wattala. Cleaned shrimp shell was washed with running water to remove any remaining muscles and membranes and dried at 60° C for 2 days continuously. Fragile chitin shells were crushed into powder using a motor and pestle. The chitin powder was deproteinized by boiling in 4% NaOH (w/v) for 2 hours. The chitin was then washed with distilled water until the pH of wash offs become neutral. Deproteinization and washing steps were continued until the wash offs become colorless. Demineralization of the deproteinized chitin was done by boiling it in 4% HCl solution (v/v). The boiling was stopped when there was no bubbles detected in excess HCl. Chitosan was washed thoroughly in distilled water and dried at 70° C for 5 hrs. The chitosan powder was boiled for 12 hours in 40% NaOH solution (w/v) for

deacetylation, washed with distilled water and dried. 250g of Commercial chitosan also was imported for another treatment.

Experimental feeds

Four diets (T_1: Basal diet; T_2: Include extracted chitosan 2%; T_3: Include commercial chitosan 2% and T_4: Include commercial chitosan 4%) were formulated

Experimental design and feeding trial

Re circulatory tank system was used in the trial with 12 glass tanks. Each feed randomly assigned to three replicates. Sixty late stage post larvae (Juveniles around 0.1g) were allocated in each tank. Shrimp were acclimated to the tank system and experimental feeds for one week. Feeding trial was conducted for 42 days. Water quality parameters (Salinity, DO and NH_4^+) were checked daily and maintained at optimum levels. Water exchange was done thrice per week and re circulatory system was run 2 hrs in a day with the flow rate of 3L/ min. Growth data were collected biweekly. After termination of feeding trial, challenge test was initiated.

Challenge test

Two WSSV infected shrimps were kept in a tub of 25L for 10 days. At the date one infected shrimp died, the water was equally separated in to 12 tanks by 2 L per each tank. Feeding was continued and mortalities were recorded.

Results:

Table 1 growth performances of juvenile tiger shrimps fed four different diets (Means±SE)

	T_1	T_2	T_3	T_4
Initial weight	0.1	0.1	0.1	0.1
Final weight	0.171	0.206	0.226	0.200
Weight gain	70.90 ± 0.31^{d}	104.58 ± 3.76^{b}	126.03 ± 10.81^{a}	99.74 ± 9.91^{c}

Progress: Physical : 85% Financial :

Outcome:

Use of low levels of chitosan shows better performances of farming level shrimps.

Recommendations:

Further studies are needs to check the appropriate incorporate level of Chitosan and improve the quality of Chitosan.

PROJECT NO : 1.13.3
DEVELOPMENT OF FEED FOR MUD CRABS

Responsible officer : Dr. (Mrs) M. G. I. S. Parakrama

Objective:
To develop an economical feasible highly nutritious feed for crab farming/ fattening

Project background/Introduction:
Mud crab farming is very recently emerged culture practice in Sri Lanka. It has been identified as an important, high protein tasty shell fish species for aquaculture in Sri Lanka. Availability of seed and appropriate feed for the culture practice are the most important issues for the development and propagation of crab culture industry in Sri Lanka. However, breeding technology has been disclosed and recently only one private hatchery has been established in the country, and they produce crab seeds to facilitate the crab farmers with providing seeds to them. The culture period being identified as 6 to 8 months vary with the culture environment and the feed availability. Trash fish is the traditional method of feeding crabs up to harvesting and as the availability of trash fish being a limiting factor as it has seasonal changes, an economically profitable nutritious feed is a timely need for the enhancement/ development of the new field.

Activities carried out:
First trial

- Selection of suitable site/ pond system to grow out culture
- Preparation of cages for culturing crabs (including cleaning, renovation of old/ previously used net cages to install in the new pond etc.)
- Purchasing of feed ingredients
- Preparing of crab feed
- Purchasing of crabs
- Experimental feed trial started at Pitipana private owners pond, using a new feed formula with 45 % crude protein level.
- Total 80 crabs were stocked in 8 cages with average single wt 230g- 238g initial length 11.5–12.5cm
- Time to time separation of molting stages in to separated cages to minimize cannibalism
- Grow out culture from average weight 200 gm to 350gm conducted.

Second trial

- Stocking of crabs for 2nd experiment
- Cages were partitioned to 8 rooms each.
- Stocked single crab in to single room (8 crabs in one cage)
- Feed trial with using 3 new feed formula F1,F2 and F3 with 45 , 40 and 32.5 % crude protein level respectively. Growth compared with trash fish/low cost fish fed treatment.
- Experimental feed trial from one moult up to hardening shell stage. (crab fattening- 21 days duration)

Results:

1st experimental trail

- Total price for 1kg of prepared crab feed is 135 to the market price.
- Survival was low (35-37%) due to moult death syndrome and cannibalism as well as crab lost due to unfavorable anthropogenic activities and security problems. However, survival of tested farm animals was better compared to the general crab farmers record (less than 15%) in grow out culture.

2nd experiment trail

Table 1 feed formulae used

Ingredients	F1	F2	F3
Fish meal (g)	37.5	23.5	55.5
Soy meal (g)	20.0	30.0	25.0
Meat/bone meal	23.0	27.0	-
Wheat flour (g)	10.0	10.0	10.0
Fish oil (ml)	9.0	9.0	9.0
Vitamin (g)	0.5	0.5	0.5
Total (g)	100	100	100
Protein%	45	40	32.5












Plate 1: 6 cage construction phase of the project

Results:

Treatment	T1 (F1 fed crab)	T2 (F2 fed crab)	T3 (F3 fed crab)	T4 (low cost fish fed crab)
Ave. single indi. wt (g)	200	185.3	189.5	164.5
Ave. single final wt (g)	287.68	338.8	274	268.2
Ave. wt gain(g)	87.68	153.43	84.5	103.6
Survival rate	87.5	87.5	81.25	87.5
FCR calculated	2.39	1.28	2.35	3.6
Cost/kg water crabs	650/=	650/=	650/=	650/=
Selling price/kg crabs (350-400g)	1650/=	1650/=	1650/=	1650/=
Cost/kg feed	165/=	165/=	155/=	125/=
Feed for 21 days per crab(5% body wt)	210g	194.6g	198.9g	172.7g
Feed for 21 days / kg crab	2.3kg	1.2kg	2.3kg	3.6kg
Profit excluding labour and pond/cage preparation/ kg crabs	1650-(650+379) =Rs. 621.00	1650-(650+198) =Rs. 802.00	1650-(650+356) =Rs. 664.00	1650-(650+450) = Rs. 550.00

According to the present results F2 feed is the best formula tested as crab feed.

Progress: Physical : 95% Financial :

Output:
Field tested feed formulae for crab farming/fattening

Outcome:
Popularizing crab farming and/or fattening among fisheries people.

Recommendations:

- Crabs can be cultured/fattened using formulated feed. According to the results the experimental formula F2 can be introduced as a low cost feed formula.
- It can be suggested that soya bean meal and/or meat bone meal have been involved in the better growth in this study (Richardson *et al,* 2006).
- Individual room per crab is recommended for culture.
- Cages should be highly protected from all possible predators such as wild fish/water snakes etc. to avoid predation on moulted crabs.

Constraints:
An unexpected problem rose regards to the ownership of the research conducted pond as it is belonging to provincial council. This led to cancellation of duty the outside person who involved in the project work. Accordingly first part of the research project was affected. The minor errors i.e. few hours delay in feeding have been badly affected to crab research due to their cannibalistic nature.

Unexpected lifting of crabs in the tested pond.

PROJECT NO : 1.13.2

PARTIAL REPLACEMENT OF FISHMEAL BY BREWERS' YEAST (*SACCAROMYCES CEREVISAE*) IN DIETS FOR SEA CUCUMBER (*HOLOTHURIA SCABRA*) JUVENILES.

Responsible officer : Mr. R. Weerasinghe

Objectives:
To find the effects of brewer's yeast (*Saccaromyces cerevisae*) in diets for Sea cucumber (*Holothuria*) juveniles

Project background/ Introduction:
Holothuria scabra is abundant and widely distributed in shallow soft-bottom habitats throughout the Indo-Pacific region. It has a high value on the Asian markets, where it is mainly sold as beche-de-mer. *H. scabra* is only tropical holothurian species that can currently be mass produced in hatcheries. People involves in this production mainly because of the demand. This demand of sea cucumber has been increased because of commercial exploitation. Due to over exploitation wild stocks are being declined. Lack of good quality formulated feeds for sea cucumber is identified as a major problem for sea cucumber seed production and farming.

Fishmeal is still the main or even the only protein source in fish feeds. Because of the most adequate amino acid profile is supplied by fish meal. Many of alternative protein sources to replace fish meal have been studied. But negative impacts have been occurred with the use of plant protein sources

as alternative sources such as, amino acid unbalances, presence of anti-nutritional factors, low palatability, a high level of replacement of fish meal with plant feedstuffs is also generally not well accepted. The key ingredient which is used in this experiment is brewers yeast and it is a single cell protein. Single cell proteins (SCP) include micro algae, bacteria and yeast, and are alternative non-conventional protein sources that are frequently used as feed ingredients for fish, due to the nutritional value of their nutrients such as proteins, B-vitamins, pigments and complex carbohydrates, such as glucans (Sanderson and Jolly, 1994; Tacon, 1994).

Activities carried out:

Experimental site

Hatchery of Regional Research Center, NARA Kalpitiya was selected for the feeding trial. Semi re-circulatory tank system was arranged with 12 round fiberglass tanks.

Experimental feeds

Four diets (T_1: 0% of brewer's yeast (Basal diet; Control); T_2: 10% of brewers yeast; T_3: 30% of brewers yeast; T_4 : 50 % of brewers yeast) were formulated.

Experimental design and sea cucumber

Twelve round and conical fiberglass tanks were used and each feed randomly assigned to three replicates. 12 sea cucumber juveniles averaging 0.9 g were allocated in each tank. Sea cucumber juveniles were procured by a private sea cucumber hatchery at Muthupanthiya, Arachchcikattuwa and Chilaw.

Feeding trial

Sea cucumber juveniles were acclimated to the tank system and experimental feeds for a week. Feeding trial was conducted for 55 days. Water quality parameters (Salinity, DO and NH_4^+) were checked daily. Water exchange was done thrice per week and re circulatory system was run 2hrs in a day with the flow rate of 2.5-3L/ min. Feeding was preceded once per day. Growth data was collected biweekly.

Results:

Table 1experimental feed compositions and proximate composition (Means ± SE)

Ingredient	T0	T10	T30	T50
Fish meal	20	18	14	10
Dry yeast	0	2	7	14
Soya bean meal	20	20	20	20
Meat and bone meal	5	5	5	5
Maize	15	15	15	15
Poonac	5	5	5	5
Rice polish	5	5	5	5
Wheat flour	26	26	25	22
Fish oil	0.5	0.5	0.5	0.5

Vitamin mineral premix	3	3	3	3
DL Methionine	0.3	0.3	0.3	0.3
L lysine	0.2	0.2	0.2	0.2
Proximate composition				
Moisture	9.05±0.35	10.54±0.79	9.45±0.01	9.73±0.11
CP	27.85±1.02	26.8±1.97	29.28±0.21	28.49±0.25
Ash	18.81±3.51	13.96±0.29	12.03±0.16	10.48±0.02
Price (Rs.)/kg	124.65	121.45	114.15	105.05

Table 2 growth performances of juvenile tiger shrimps fed four different diets (Means ± SE)

	T_1	T_2	T_3	T_4
Initial weight	0.9	0.9	0.9	0.9
Final weight	1.63±0.15	2.39±0.12	1.97±0.09	1.84±0.22
Percent Weight gain	$81.03±16.82^{c}$	$165.61±12.88^{a}$	$119.08±9.71^{b}$	$104.61±24.82^{b}$
Survival rate (%)	77.8	86.1	86.1	94.4
Cost (Rs/kg)	125	121	114	105

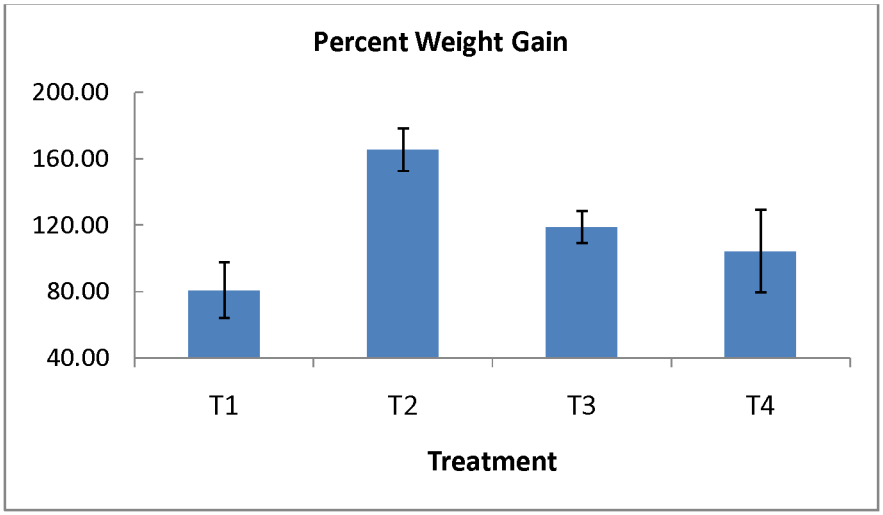


Figure 01: Percent weight gain of sea cucumber juveniles fed four different diets

Progress: Physical : 85% Financial :

Output:

Replacement level of high valve fish meals by brewers' yeast closer to 10 % and lower to 30% in sea cucumber diets

Outcome:
Use of brewers' yeast in sea cucumber diets would be cost effective and effective to boost the growth in a short period.

Recommendations:
Further studies are needs to check the development of micro elements in diets by brewers yeast incorporation.

PROJECT NO : 1.14

DEVELOPMENT OF CULTURE TECHNIQUES IN SELECTED SEAWEED SPECIES AND QUALITY IMPROVED PARENT STOCK MAINTENANCE OF COMMERCIALLY IMPORTANT SEAWEEDS

Responsible officers : Mr. S. Jayanatha
Mr. H. Galahitigama
Dr. V.Pahalawattaarachchi

Background justification
Seaweed industry in Sri Lanka is has become a thriving industry with commercial initiatives of *K. alvarezii*. In other way there are more than 300 species of seaweeds available alone the coastal areas in Sri Lanka only two species are utilized in commercial/ edible purpose. Culture of these species would be much helpful to supply of raw material needed and to promote sea based food in Sri Lanka. Although (*K. alvarezii*) culture has become to commercial status within a 5 years development period, there are several issues to be addressed in order to further expansion of the industry. **Inadequate quantity of seed stock** is the major barrier for expand the industry. Improvement of quality of the seeds is another prior requirement in the industry. It is prime important to keep a good quality seed stock under government patronage as industry has long way forward to cater the huge demand of *K. alvarezii* which is presently not sufficient at all.

Culture of seaweed in the open sea is severely affected **with the monsoonal pattern** and the seeds cannot be kept during the rough weather using existing square cages. So that it was suggested to conduct experiments using round type cages.

Objectives :
Development of culture techniques for potential species of seaweeds and maintain improved parent seed stock of *K. alvarezii* to cater the need of the industry

- Introduce cultivation techniques for *Sargassum* and *Ulva* species
- Improve the vigor of seed stock of *K. alvarezii*
- Development of structures(rafts) for deep sea to continue culture cycles during the rough sea conditions
- Mapping of culture sites and possible areas

Materials and Methods

Twelve (12) number of 1.5mx0.5mx0.5 m cages maintained at Devinuwara sea and culture was conducted through mass selection. Grow out trials on modified cylindrical cages 06 cages (each) suitable for rough sea conditions (May to Oct-Rough season) were carried out at Devinuwara. Four experimental trials, 02 in calm season and 02 in rough season were conducted using each structure. Mass selected previously cultured seeds at Dondra culture site, were used for the trial. Initial planting was done in round cages using 100g, 150g, and 200g propagules attached to the ropes with 25cm distance between two propagules. Initial wet weighs were recorded before attaching to the ropes and final weigh measurements were taken after 1.5 months. Water quality parameters and oceanographic conditions were monitored every fortnight.

Culture trials of Ulva

Initial trials for spore releasing of *Ulva* were conducted in 2017. Spore releasing was activated using different shock treatments such as temperature, dehydration, and salinity.

Different steps used in spore releasing activity through temperature shocks.

- 15 g *Ulva* subjected to temperature shocks 2^0C, 4^0C and 6^0C
- 5 g of temperature shocked samples were crushed using a mortar and pestle
- Using the same procedure 2^0C, 4^0C, 6^0C and room temperature treatments were given for 5, 10 and 15 minutes separately
- 36 samples were incubated at 25^0C
- Observations were made for the spore releasing activity

Activities carried out:

- Continuation of seed propagation through mass selection using existing cages
- Repair and construct additional cages
- Modified Cylindrical Cage construction
- Design and construction of modified rectangular/circular cages
- Planting with good quality seeds
- Deployed cylindrical cages in Devinuwara in Southern coast and maintenance
- Monitoring growth and water quality
- Experimental trails on Sargassum culture
- Experimental trials on Ulva culture
- Mapping cultured sites and potential areas

Results

Production of *K.alvarezii* at round and square shape net cages was carried out. During the rough condition, round cages were easy to handle and maintain due to circulation of cages around axis. Also the mechanical damage could be overcome by fixing the cages to high strength survival in the bottom axis. The growth patterns in round and square cages were similar in calm season and there was no significant difference observed between SGR of those. Highest SGR% was recorded at fist two weeks in round and square cages. After that, SGR% has steadily decreased. It may affect high densities in bunches due to the high growth of seedlings.

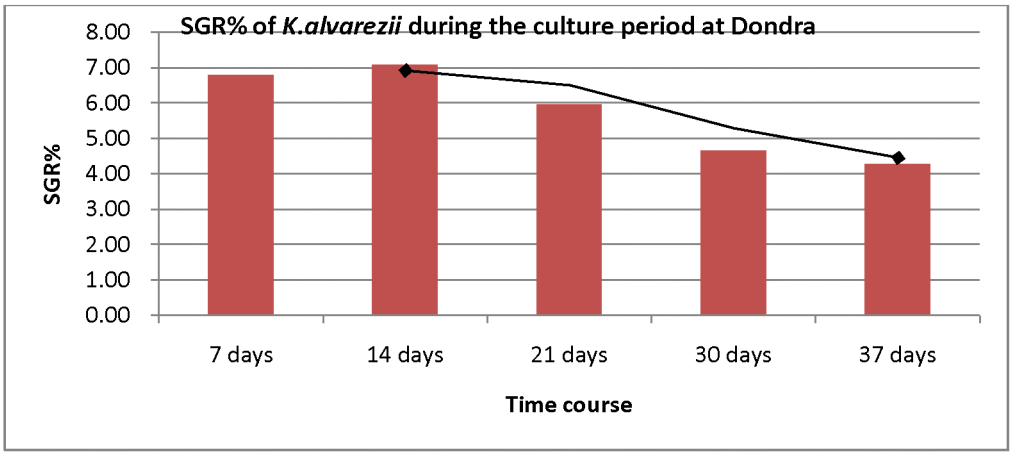


Fig. 1: Variation of specific Growth Rate of ***K. alvarezii*** cultured in round cages during the calm condition.

The highest average growth increment was observed from 10 to 20 days in round cages while 20 to 30 days the growth increment remained slight decrease or same. This could be attributed to external forces such as rough wave conditions may affect to break the seaweed bunches. The purpose of round cages were to keep the seeds in the rough season so that it is recommended to have less growth increment after 20 days to keep the seeds in the same cage. So that limited number of cages could be used for seed storage in rough weather conditions.

The capacity of 01 cage was 50-100kg. Vast range was due to the external forces. So that it could be able to keep 500-1000kg of seeds at the nursery for one time. The seeds were delivered to two community farmers at Mannar and other seeds were utilized for the experiments and for storage.



Fig.2: Round cages and inserted seeds materials.

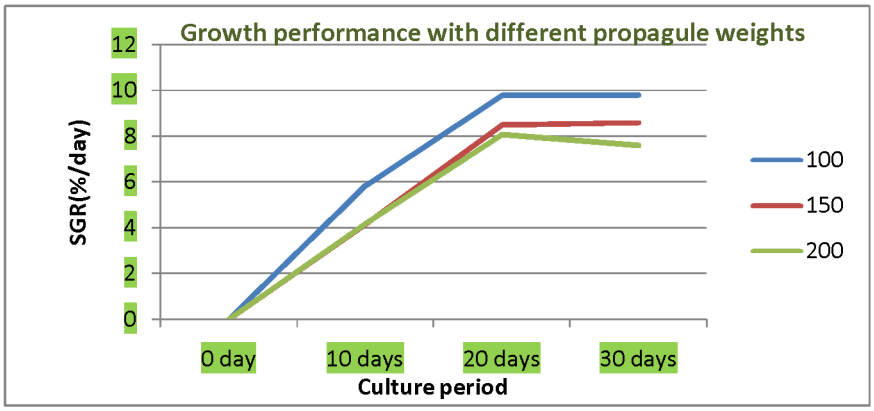


Fig.3: Growth performance with different propagule weights in the round cages in rough season

Specific Growth Rate of ***K. alvarezii*** different seedlings density in cages during the rough season (August to October). Highest SGR% showed in 100g seedlings installed cages. Moreover, SGR% is elevated beyond 10 days trails of round cages.

It was appeared that average SGR in the seaweeds of calm season was in the range of 4-6% while it was 4-10% in the rough wave condition. This proves that the weight increment is fast at rough weather conditions.

Ulva Culture

The results indicated, temperature, dehydration and salinity were the factors which significantly affect on the release of swarmers in *Ulva lactuca*



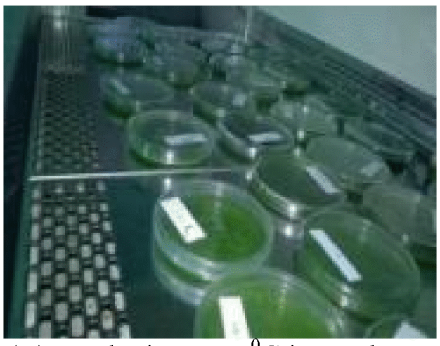


Fig4: (A) *Ulva lactuca;* (B) Incubation at 25^0C in a culture cabinet

Highest swarmer density was obtained when the thallus was exposed to 2˚C temperature shock for 10 minutes. Long-time expose to 2˚C and 4˚C were not increased further swarmer production.

Maximum spore density was obtained when thallus was exposed to 30 minutes dehydration. In the experiment no two, higher swarmer density was gained under constant temperature shock (2˚C), constant light and humidity condition than only giving temperature shocks. Within the range of salinity level of 20 ppt to 40 ppt, swarmer densities were increased.

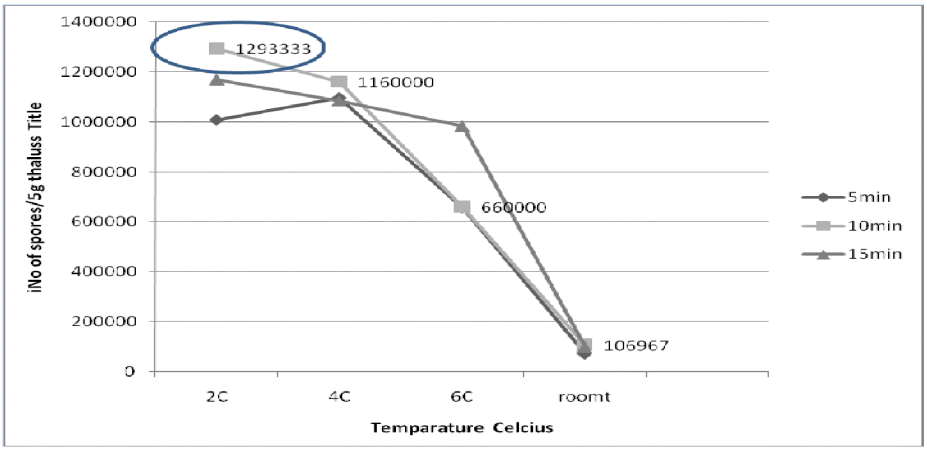


Fig 5: Variation of releasing spores with time and temperature combination

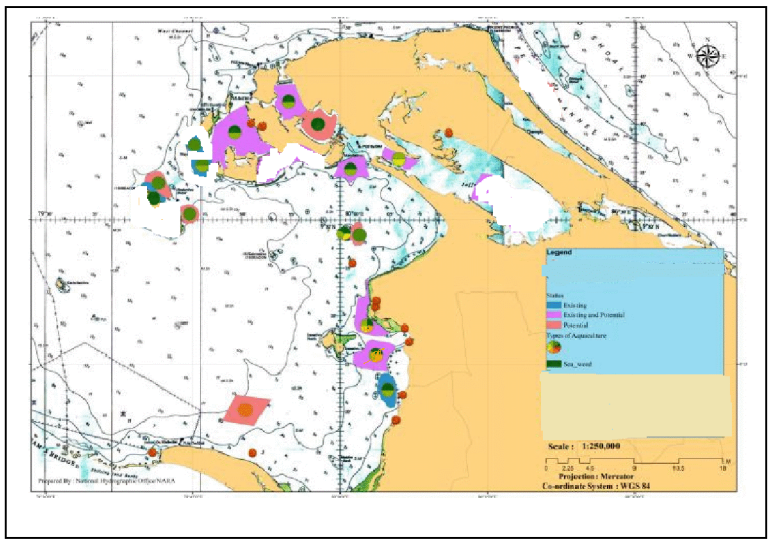


Fig 6: Culture sites and potential areas for seaweed culture



Round and square cages and inserted seeds materials.



Rectangular and round structures in culture site at Dondra seed materials

Progress: Physical 85% Financial

Output:

- Introduce round cage for storing seeds in rough season
- Introduced technology for Ulva spore releasing

Outcome

Ensure continues seed supply for the growing seaweed industry in Sri Lanka.

Recommendations

- Most suitable propagule size for growing in the cages is 100g.
- The round type cages can be used to storing seeds of the K. alverezii during rough weather conditions
- By improving the cages higher yield of K. alverezii can be obtained in the rough season due to high growth rate.
- Mass selection procedure is best way to propagate seedling for maintained quality seeds.
- Highest swarmer density was resulted when thallus was dehydrated for 30 minutes followed by temperature shock at 2˚C for 10 minutes and incubated in 30ppt filtered autoclaved seawater. In economical aspect, this can be used as baseline method for mass production of swarmers in tropical Ulva lactuaca.
- Ulva culture should be continued with grow out trials

PROJECT NO : 4.1.1
MANAGEMENT OF VIRAL DISEASE IN SHRIMP INDUSTRY IN SRI LANKA

Responsible officers : Mrs. M.L.Rasika Thanthrige and new recruit

Objectives:
- Continuation of the ongoing studies on monitoring of WSSV disease including study on possible carriers, introduction of low cost test kit and study on genotypic variation of the WSSV disease.
- Development of diagnostic methodologies to other common viral diseases of shrimp in the region; IHHNV disease.

Project background/ Introduction:
To date, more than twenty viral diseases have been reported to affect shrimp and prawns, and five viruses are identified as most significant viruses: IHHNV, YHV, TSV, WSSV, and IMNV. GAA survey revealed that 60% of losses were attributed to viruses and high sensitive PCR can detect viruses soon after infection and even before the onset of disease. Major disease threat is White Spot Syndrome Disease within past decades in Sri Lanka and main concern of the stake holders and to researches about WSSV. Apart from that stake holders requested to develop the diagnosis methodologies to other potential viral diseases such as IHHNV and Leam-sing viral disease. Some studied carry out in the past decades revealed that IHHNV and Leam sing viral diseases found in north western region of Sri Lanka. _IHHNV infection can reach 90% of cumulative mortality and develop a runt-deformity syndrome, with abnormalities such as bent or deformed rostrums, wrinkled walking legs, cuticular roughness, and other cuticular deformities.

Activities carried out:
- Literature review and Procumbent of Chemicals and consumables for the WSSV,IHHNV diseases
- Purchasing of test kits for WSSV, IHHNV disease
- Cultured p. monodon Shrimps, non cultured shrimps and other crustacean species found surrounding in the shrimp ponds and hatcheries were collected as sample.
- DNA Extraction , PCR amplification and Gel electrophoresis for WSSV disease
- Optimization of the diagnostic procedures for IHHNV viral diseases
- Sequencing of the diseased samples
- Genotype analysis
- Report writing/ publications

Results:
Totally 729 tissue samples of 11 possible carrier species were screened and 143 individuals were positive for the WSSV disease by 2-step nested PCR. The study revealed that WSSV virus prevailence in gills or pleopods or leg part of the hosting species. Those species are Sand white ghost crab (*Ocypode ceratophthalmus*), Mud crabs (*Scylla olivacea*), Mangrove crabs (*Scylla serrata*), Blue swimming crab (*Portunus pelagicus*), Wild Shrimp *(P. indicus* from sea), Three spotted swimming crab, Brine shrimp/Artimea, Mole crab and Pond crabs living around the dams of the farm ponds.

There were no positives were recorded in Bivalves (*Marcia opima*) and Cuttle fish. These species may have potential to act as carrier species to the healthy *P. monodon* farms.

Table 1 Crustacean species and its prevalence of the WSSV disease.

Life stage / Type	No. Of Samples	No.of Positive samples	WSSV Disease Prevalence
Mud Crab	119	35	29%
Mangrove Crab	29	11	38%
Mole Crab	55	1	1.8%
Wild shrimp	174	7	4%
Sand White Ghost Crab	24	11	46%
Pond Crab	24	2	8%
Blue Swimming Crab	167	61	36%
Clams	26	0	0
Three Spotted SwimmingC.	73	19	26%
Artimia	38	5	13%
Cuttle fish	11	0	0

The samples were collected from major three fisheries districts in the North Western region such as Negombo, Chilaw and Kalpitiya. Therefore area wise risk species were analyzed. The high risk species in Chilaw area are Sand white ghost crabs, Blue swimming crabs and the mud crabs. The disease prevalence in Negombo area found as Mangrove crabs, Blue swimming crabs and mud crab. In kalpitiya area the high risk species are Blue swimming crab mud crab and mangrove crab.

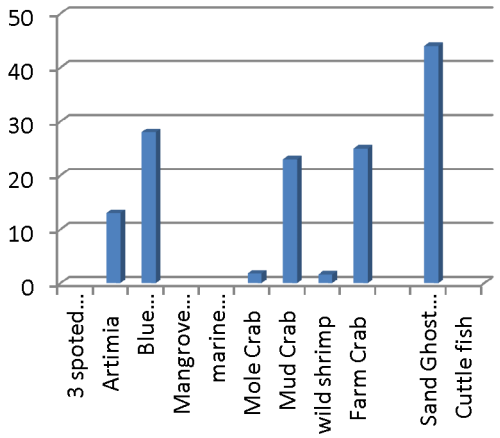


Figure 1: Risk species analysis in Chilaw

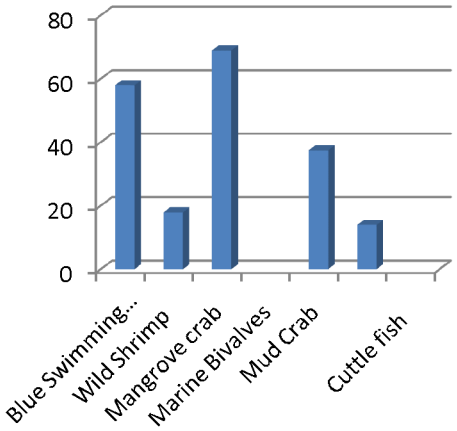


Figure 2: Risk species analysis in Negombo

The research conducted to identify the genotypic variation of the WSSV disease in Sri Lanka is almost finished and have to do sequencing and analyzed the sequencing data. The research on comparison of IQ 2000 ™ WSSV Detection and Prevention kit with the Dr. Sahul Hameed's WSSV detection kit now there were more than 250 samples were comparatively tested with above two kits and remain

the analyzing part. Chemicals were purchased and procedure was standardized to diagnose the IHHNV disease and the project will continue to the next year.

Progress: Physical: 80% Financial:

Output:
Identified possible carriers of the wssv disease

Outcome:
Cater to the shrimp aquaculture sector by managing the viral diseases conditions.

Constraints:
Lack of sufficient staff (a scientist and a research assistant) to carry out the laboratory research works some target could not be achieved.

PROJECT NO : 4.1.2
WATER QUALITY VARIATIONS AND CLIMATE CHANGE ADAPTATION

Responsible officers : Mrs. A.S.L.E. Corea

Objectives:
- To determine the effect of water quality on production in different areas of the lagoon system
- To investigate whether low fertility of brooders, low hatching rates of eggs and low larval survival is caused by temperature effects.

Project background/ Introduction:
Shrimp farming is the major export oriented aquaculture practice at present. The farmers face many problems due to the available water quality for culture purposes; specially during adverse weather conditions Farmers also faced a problem of not having sufficient post larvae as hatcheries were affected by low fertility, low hatching rates and low larval survival during this year, which was thought to be a problem related to water temperature .

Farmers have requested to find the underlying causes for preventing production increase and give recommendations. Production data under different climatic conditions will be collected with water samples in the different parts of the lagoon system to find the effect of temperature and salinity changes on the production. During the last floods and the previous drought period, highest production was obtained by farmers who managed water quality within acceptable ranges. However since most farmers do not have methods of reducing salinity during drought periods, due to lack of fresh water , salinity maintenance was not possible and they had to depend on lagoon water. Therefore changes in lagoon water quality affected the production .as well as resulted in abnormal conditions. The disease prevalence also would change with the temperature changes.

Another major problem which affected the farmers during the last year was the issue of changing temperature in hatcheries. The egg fertility and the larval survival were affected by the low temperature as well as the high temperature periods. The study hopes to investigate the egg fertility

and larval survival at different temperature ranges with nutrition to provide a solution to this problem. The present study investigated the water quality changes with temperature in the lagoon and also studied the temperature effects in hatcheries .

Activities carried out:

- Collect samples from water source.
- Collect shrimp samples for disease analysis.
- Monitor brooder samples and their egg fertility at different temperatures

Water samples were collected monthy from selected points in the lagoon (Lower dutch canal, upper dutch canal and Mundel lagoon). Data on number of farms stocked and harvested were also collected for each water source Disease conditions under different water quality conditions were recorded with farmers perspectives on reasons for disease occurrence.

Hatcheries were visited once a week and data was collected on the daily water temperature in the brooder tanks and hatching tanks as well as number of eggs and number hatched. The study could not be carried out to investigate the effect of temperature on different larval stages.

Results:

During the early part of the year water temperature ranged between 30°C – 32°C during day time. However farmers informed that the night time temperature was less than 28 °C. During this period the shrimps were infected with a disease condition where the head part turned red or orange and mortality was observed. Farms that did not harvest with the onset of these symptoms also got WSSV after a few days (4-5 days) The disease conditions was thought to be Yellow head disease which was not confirmed. It was also thought to be a bacterial infection which affected the week shrimp due to temperature stress (high diurnal temperature variation) as high bacterial counts had been observed by CADDAR. However water quality in the source water was in the suitable range for shrimp culture during this period.

Table 1: Measured water quality parameters

Site	Measured water quality parameters				
	Nitrite (mg/l)	Total Ammonia(mg/l)	pH	Salinity(ppt)	DO (mg/l)
Zone1	0.009 – 0.20	0.00 – 0.2	7.9 – 9.0	10 -20	3.8 -5.0
Zone2	0.01 – 0.30	0.02 – 0.11	7.8 – 8.5	12-20	4.0-4.7
Zone3	0.001 – 0.09	0.008 – 0.09	7.5 – 8.2	14- 28	3.9 – 4.8
Zone4	0.002 – 0.11	0.01 – 0.1	7.7 – 8.8	15 - 30	3.6-5.2
Zone5	0.000 – 0.105	0.03 – 0.21	7.2 – 8.7	20 - 30	4.2-5.1





The condition changed after the day night temperature variation became normal; but the salinity in lagoons increased steadily, since the Puttalam district did not receive any rains up to September. With increasing salinity farm stocking was reduced and very few WSSV incidences were reported.

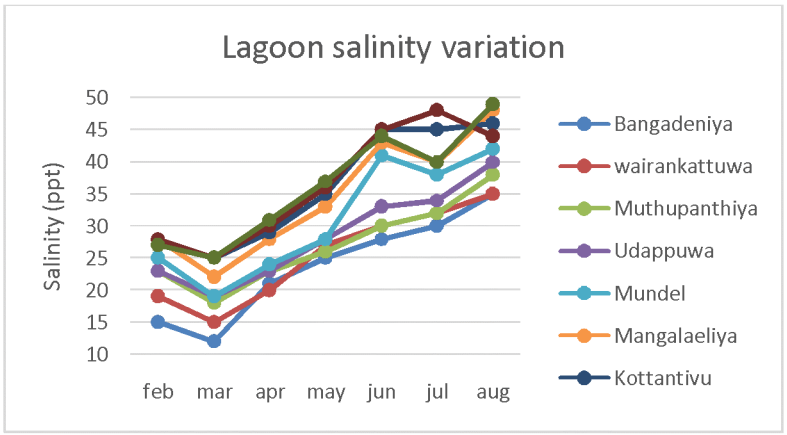


Figure 1 :Lagoon salinity variation

Ammonuia andnitrite levels were within suitable range for aquaculture but ammonia showed a positive relationship to salinity while nitrite and nitrate showed a negative relationship to salinity. The fecundity of shrimp at temperatures 29°C, 30 °C and 31°C were not significantly different .It was 283.3±17.8, 294.5 ±12.1, and 279.8 ±15.5 respectively.The hatching rate was also close to 80 %for all 3 temperatures .The hatching rates were 225.4 ±11.8, 234.1± 9.6 and 218.6 ±12.3 respectively. The study did not take into consideration the salinity level at which the results were observed as all hatcheries maintained a salinity level between 32 -34 ppt during the study period.

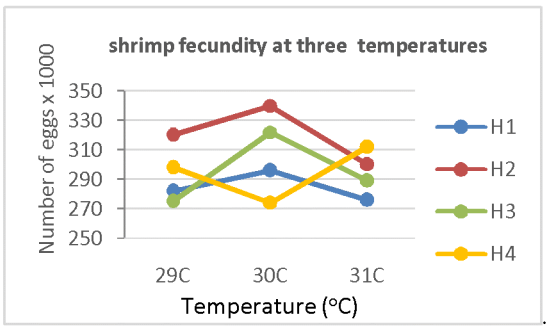


Fig 2: Shrimp fecunditiy at three temparatures

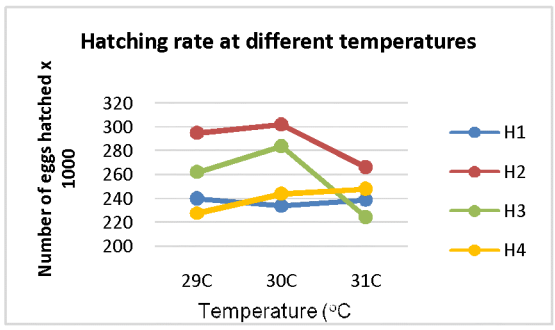


Fig 3: Hatching rates at different temparatures

However, according to literature the salinity and brooder condition also have an effect on fecundity and hatching as well as larval survival .The combined effects of these conditions will decide the numbers of eggs and nauphili produced, as well as their development into successful larvae. Larval survival and moulting also would be affected by the combined effect of these factors.

Progress: Physical 75% Financial

Recommendations

- The increase in high salinity reduces diseas incidence but farmers do not stock at high salinities as this would retard growth. Therefore production is affected by prolonged drought causing high salinity in the lagoons
- The temperature range studied has no significant impact on shrimp fecundity or hatching Therefore the studies can be extended accordingly as suggested.
- The present study needs to be extended to cover the temperature ranges below 29°C (28 &27 °C) as well as higher temperature ranges about 32 °C.
- It also should be repeated at salinity level less than 33ppt (31-32 ppt) as well as salinity levels of 34 & 35
- The survival of larvae need to be studied to make sure that larvae produced at these temperatures are healthy and have a good survival rate .It is therefore necessary to extend observations upto the post larvae stage and check their health condition.
- Monitoring farming conditions with the larvae produced under the specified conditions would indicate the growth performance and survival in shrimp farms indicating its impact on production

Output:

Information on environmental conditions related to disease outbreaks and shrimp brooder performance

Outcome:

Improve shrimp production by managing the culture environment

Constraints:

- Unavailability of vehicles at the required time for field work.
- Received most of the equipment only at the end of the year. One (refrigerator) was never received.

List of Publications

Papers presented and proceedings

1. Adikari, A.M.A.N., Edirisinghe, U., E.D.M. Epasinghe, H.M.P. Kithsiri, V. Pahalawattarachchi, T.A.D.W. Karunaratne, (2017). Development of an artificial breeding and hatchery technique for exotic ornamental fish *Sahyadria denisonii* (Day, 1985*) In: Proceeding of 29th Annual Congress of PGIS, University of Peradeniya.* 33p.

2. Ariyawansa, K.W.S., S. Gallage, P. Ginigaddarage, K. Hettiarachchi, G.P. Roshan, C. B Madagedara and H.M.P. Kithsiri (2017). Assessment of microbiological quality of oysters

(*Crassostrea madrasensis*) harvested in different locations of Puttalam Lagoon in Sri Lanka*: In: Proceeding of Annual Scientific Session of National Aquatic Resources Research and Development Agency (NARA), Colombo.*

3. Ashika, F., Hirimuthugoda, N.Y., and Pahalawattaarachci, V. 2017 Establishment of Gracilaria edulis propagated bt raft culture method in Puttalam lagoon, Sri Lanka. Annual Scientific Session of NARA 2017, July 27, Colombo, Sri Lanka; 11pp.

4. C. Perera (2017). Economical and optimum fish protein: plant protein requirement for the growth performance of fry stage of Tinfoil Barb (*Barbonymus schwanenfeldii*) *In: Proceeding of* 23rd *Annual Scientific Sessions of Sri Lanka Association for Fisheries and Aquatic Resources (SLAFAR), Colombo.*

5. C. Perera (2017). Effects of the extruder die temperature on some physical properties of extruded fish feed pellets containing wheat flour and corn flour as starch sources. *In: Proceeding of* 23rd *Annual Scientific Sessions of Sri Lanka Association for Fisheries and Aquatic Resources (SLAFAR),* Colombo.

6. Epasinghe M., Perera G.S.C., Kithsiri H.M.P., Pahalawattarachchi **V.,** Adikari A.M.A.N and T.A.D.W.Karunaratne and Maduaka, K.L.W.T. 2017 Effect of extruder die temperature on some physical properties of extryde fish feed pellets containing wheat flour and corn as starch sources. Annual Scientific Session of NARA 2017, July 27, Colombo, Sri Lanka; 2 pp

7. Gammanpila,M., Dhanayaka,D.DG.L., Pahalawattaarachchi**, V.** and H.M.P.Kithsiri 2017 Variations in water quality conditions and functional habitats in Negombo lagoon with special reference to Seabass cage culture practices, Proceedings of 4th International Conference on Fisheries and Aquaculture held at Colombo.

8. Gunasekara' A. M. G. U. and M. G. I. S. Pararama (2017). Study to investigate the effect on immunity status of koi carp (*Cyprinus carpio*) fingerlings fed diet augmented with *Coriandrum sativum* to *Aeromonas hydrophila* infection. A paper submitted to *Sri Lanka Jourbal of Aquatic Science* (accepted).

9. Jayasinghe, P. S.; V. Pahalawattaarachchi**,** K.K.D. S. Ranaweera and R. Perera 2017 Dietary fiber content , fatty acid and starch digestible rate of seaweed and seaweed based products in Sri Lanka. Annual Scientific Session of NARA 2017, July 27, Colombo, Sri Lanka; 63 pp

10. Kumarasinghe D.R., Athauda A.R.S.B., Kumara P.A.D.A and R. Weerasingha (2018). Effects of brewers' yeast on growth performances of juvenile sea cucumber (*Holothuria scabra*) In: *Proceedings of Faculty of Agriculture Undergraduate Symposium, University of Peradeniya* .40p.

11. Mallawaarachchi, M.A.J.C., Pahalawattaarachchi V. and Kithsiri H.M.P. (2017). Efficacy of natural oil enriched A*rtemia* on growth and survival of seahorse fry (H*ippocampus kuda*) *In:* 4th *International Conference on Fisheries and Aquaculture (ICFA) 2017, Colombo.*

12. Nishanthan, G., P.A.D. Ajith Kumara, M.D.S.T. de Croos, D.V.P. Prasada and D.C.T. Dissanayake, (2017). Proximate composition of fresh and processed six commercially important sea cucumber species. *In: Proceeding of 23rd Annual Scientific Session of Sri Lanka Association for Fisheries and Aquatic Resources (SLAFAR),* 32p.

13. Nishanthan, G., Ajith Kumara, P.A.D., de Croos, M., Pahan Prasada, D. and C. Dissanayake (2017). Effect of domestic and commercial level processing on proximate composition of six commercially important sea cucumber species of Sri Lanka. *In: Proceeding of International Research Symposium -Uva Wellasa University*, 153p.

14. Pahalawattaarchchi,V. and G.Dahanayaka 2017 Ensuring seagrass ecosystem values are incorporated with coastal area planning in Sri Lanka , Poster presentation at the Seagrass and Dugong Technical Workshop ; 13 March to 14 March 2017 ain Abu Dhabi, United Arab Emirates.

15. Shirantha R. R. R. A., K. S. Chandrathne, J. P. Kumara and H.M.P. Krithsiri (2017). Behavioral response of *Labeo fisheri* (Cyprinidae) to riverscape changes; linking river fish ecology and conservation. *In: Proceeding of International Wildlife Symposium*, Colombo.53p.

16. Shirantha, R.R.A.R. (2017). Policy frame on fish biodiversity management in transboudary rivers of Sri Lanka. (Giri, S.S. Ed) pp 85-124, South Asian Agriculture Regional Cooperation, (SARRC), Dhakah, Bangladesh.

17. Thanthrige, M.R.L., Jayanatha S., Narasinghe R.V., Pushpakumara J., and Pahalawattaarachchi V. (2017), Identification of possible carrier species responsible for horizontal transmission of white spot syndrome virus (WSSV) disease to cultured *Penaus monodon., In:* of Annual Proceedings *Scientific session of National Aquatic Resources Research and Development Agency (NARA)Colombo,* 6p.

18. Thilakshi E., N.Y. Hirimuthugoda, C.B. Medagedara and P.A.D. Ajith Kumara (2017). Effect of two commercial feeds on growth and survival of the sea cucumber *Holothuria scabra* larvae: *In: Proceeding of Annual Scientific Session of National Aquatic Resources Research and Development Agency (NARA),* Colombo..

19. Weerasingha R. , N.B.P. Punyadewa, V. Pahalawaththarachchi and H.M.P. Kithsiri (2017) Preparation of fishmeal as a possible method to eradicate *Pterygoplichthys* species (Amazon Sail fin Catfish and Vermiculated Sailfin catfish) from Sri Lankan Reservoirs. *In : Proceeding of the National Symposium on Invasive Alien Species, Colombo* 25p.

20. Weerasingha R. and D.A. Athukorala. (2017). Comparison of nutrient levels of fish meal prepared from scavenger fish species (Genus: Pterygoplichthys) with locally produced commercial fish meal. *In: Proceedings of Annual Scientific Sessions of National Aquatic Resources Research and Development Agency (NARA), Colombo*. 3p.

21. Wikramarachi, B.R., Hirimuthugoda, N.Y, Rajapakshe, A.D.W.R. (2017). Assessing the impact of natural carotenoids on skin pigmentation of Oscar fish sing photo shop software as the analyzing tool. In : Proceeding of 23rd Annual scientific sessions of Sri Lanka Association for Fisheries and Aquatic Resources (SLAFAR), Colombo.

22. Pahalawattaarachchi, V. 2017 Seaweed resources with aquaculture potential in Sri Lanka presented at the Conference Mapping out value chain for development of a seaweed industry in Sri Lanka, 2nd May (Tuesday), Hotel Galadari, organized by SLINTEC

Full papers

1. Dahanayaka D.D.G.L,' H.D. Wimalesena, V. Pahalawattarachchi (2015) Potential of the conservation oriented mangrove based ecotourism; a case study of Kadolkele Mangrove Reserve, Negombo, Sri Lanka, Journal National Aquatic Resources Research and Development Agency , vol 44 , 31-44.(Journal appeared in 2017)

2. Kodithuwakku H., M.G.I.S. Parakrama'P.P.M. Heenatigala and V. Pahalawattaarachchi (2017). A comparative laboratory trial on the effect of *Sargassum wightii* incorporated formulated feed on growth performance and immunity development of Asian sea bass *Lates calcarifer* (Bloch 1790): Can it be an alternative to commercial feed? *Sri Lanka Jourbal of Aquatic Science*. 22(2). Pp

3. Weerasingha,R. Pahalawattaarachchi, V. (2016) Present status of the coral community in Bar Reef Marine Sanctuary in Sri Lanka , Sri Lanka Journal of Marine Environmental Sciences, vol1 , 9-16.(Journal appeared in 2017)

4. Shanmugam,K., Sivaram,E. Rajeev,V. Pahalawattaarachchi, P. N. Chandraratne, J. M. Asoka and Abhiram Seth (2017) Successful establishment of commercial farming of carrageenophyte *Kappaphycus alvarezii* Doty (Doty) in Sri Lanka: Economics of farming and quality of dry seaweed

Technical expertise rendered for different institutions/persons

1. To CEA - Ihala Kanduru-Gal-Dola mini hydro power project in Rathnapura district.
2. To CEA - Madapitiya mini-hydro power project at Hunguranketha in Nuwara-Eliya district.
3. To CEA - Proposed Degalahinna and Medapitiya mini hydro power projects in Haduranketha in Nuwara-Eliya.
4. To CEA -Proposed Kotmale and Sheen Ella mini-hydro power project at Nuwara Eliya district.
5. To Department of Chemistry of University of Colombo - Export of crystal clear strain of Devario rerio for research purpose.
6. To Marine Environment Protection authority - habitat reforestation program at Kandakuliya.
7. To Ministry of Agriculture, Irrigation, Fisheries, Animal Production & Health and Agrarian Development of Western Provincial Council - Water quality of water sources and soil quality of mud ponds of Aquaculture Breeding Center at Pitipana, Negombo.
8. To MRARD -Fishing and Export banning of Cephalopholis sonneratii.
9. To A/L students - knowledge and information on aquaculture, ornamental fish culture etc for subject specific assignments.
10. To fish culturists - treatments for the disease with samples analyze.
11. To interest people- Technical knowledge on biodiversity, endemic fishes and their conservation.
12. To Loadstar company, Midigama - Investigation and report on "Fish kill incident", 10th Feb. 2017.
13. To ornamental fish farmers - information and instructions on ornamental fish breeding, and directed them for correct path to have responsible aquaculture practices.

14. To ornamental fish farmers - information and instructions provided on fish feed formulation, freshwater prawn culture, food fish culture, tank preparation etc on their request.
15. To undergraduate students - technical knowhow and theoretical knowledge on fish nutrition, fish feed formulation and preparation, feed enrichment, feed management and feeding.

Technical meetings attended

1. Control of antibiotic use - organized by Ministry of Health and Indigenous Medicine
2. Crop calendar meeting for shrimp culture -organized by NAQDA
3. District fisheries meeting – organized by District Secretariat Puttlam
4. Investment development - organized by MFARD
5. Shrimp culture development -organized by Ministry of Primary Industries
6. Aquaculture steering committee meeting, NAQDA
7. IAS meeting , Mahaweli and Environmental Ministry
8. Meetings at Biodiversity secretariat
9. Meeting at Ministry of Fisheries and NAQDA

Different technical committees represented

1. Aquaculture Technical Committee - NAQDA
2. Issues of kite surfing on Puttalam lagoon -District Secretariat of Puttalam.
3. Monitoring committee -Moragolla Hydropower project of Ceylon Electricity Board.
4. National Steering Committee - National Biodiversity Strategic Action Plan of Bio Diversity Secretariat.
5. Regional fisheries coordinating committee - Divisional Secretariat of Puttlam.
6. Special committee -Alien Organisms Control Act –Bio Diversity Secretariat
7. Steering committee – Sri Dalada Maligawa Development Project, Central province Urban Development Authority.
8. Wild Life Research Committee – Department of Wildlife Conservation.
9. Mangrove expert committee

Guest lecture delivered

1. Aquatic bio resources, conservation, and management for trainers - Senior Certificate Course in Wildlife Conservation, National Wild life Research and Training Center, Giritale.
2. Crab Farming for Aquaculture Technology Committee, July 2017, NAQDA, Baththaramulla.

3. Fisheries and related rules & regulation of Sri Lanka" for Naval officers - Naval base of Trincomale.
4. Sea Cucumbers for Aquaculture Technology Committee, May 2017, NAQDA, Baththaramulla.
5. Status of sea cucumber fishery: past experiences from CENARA Phase I project and way forward from present to future, CENARA workshop, April 2017, District Fisheries Office, Mannar.
6. WSSV carrier species and its severity to the sector for the shrimp farmers for hatchery owners and to other shrimp related stake holders in Northwestern region, Chilaw.
7. Fish Nutrition and feed processing -for undergraduate students of Open University, Sri Lanka.
8. Seaweed culture , University of Wayambe
9. Seaweed culture, University of Uvawellassa
10. Mangrove and seagrass ecosystems, Ocean University
11. Seaweed resources with aquaculture potential in Sri Lanka, at SLINTEC

Community based projects initiated

1. Seahorse culture project was initiated; Negombo
2. Aquatic plant culture; Kalutara,
3. Ornamental fish culture; Colombo, Kalutara, Gampaha
4. Seaweed culture; Devundara, Killinochchi,
5. Oyster culture;Puttalam
6. Seabass culture ; Puttalam
7. Seacucumber ; Puttalam, Mannar

Training programs conducted

1. Fish feed and nutrition and induced breeding for members of Galle District Ornamental Fish Society funded by Southern Province Development Authority and organized by NAQDA,.
2. Fish feed production for Gampaha district ornamental and food fish farmers organized by Agriculture Ministry of North Western Province.
3. Initiated consulting works for Pitipana Aquaculture Development Center, Negombo on feed development activities under Ministry of Agriculture, North Western Province.
4. Ten day training - Ornamental fish Breeding, Culture and Management including induced breeding of ornamental fish species.
5. Three day training course - Livelihood development of ornamental fish farmers in Colombo, Kalutara and Gampaha districts through breeding high value ornamental fish species using induced breeding techniques, MFAR-02 funded project.

6. Two day training - ornamental fish breeding for 32 prisoners at new magazine prison.
7. Two day training program - newly formed surveillance team for coastal resources conservation at Kalpitiya on 24th and 25th November 2017 titled 'Survey methods of coral reef and reef fish assessments.

Awareness programs conducted

1. Aquatic plant culture for Beneficiaries of the community based project
2. Community-based Sea Cucumber Farming – for fishers in Illipantivu, Puttalam in the North western province of Sri Lanka, August 2017.
3. Community-based Sea Cucumber Farming- for fishers in Rodhapaddu, Kalpitiya in the North western province, April 2017.
4. Community-based Sea Cucumber Farming –for fishers in Serakkuliya, Puttalam in the North western province of Sri Lanka, August 2017.
5. Fish disease diagnosis training - for fisherman at Deduru Oya area, 08 August 2017.
6. Sea Cucumber and Oyster culture - for students of University College Anuradhapura, at RRC Kalpitiya.
7. Sea cucumber culture and Oyster culture - for (B. Sc.) Aquaculture and Fisheries undergraduates of Wayamba University of Sri Lanka, RRC Kalpitiya.
8. Sea Cucumber culture, Oyster culture and Sea weed culture - for agriculture undergraduates of Rajarata University of Sri Lanka at RRC, Kalpitiya.
9. Colombo Sea Food Festival of NARA, 08th to 10th December 2017, Green Park, Colombo.

Education program attended as resource person

1. Demonstration on "breeding trial of Sea cucumbers" conducted for under-graduate students of University of Sri Jayewardenepura, 06th of August 2017.
2. Education program for 120 students of Sangamiththa college, Galle, 09 February 2017.
3. Education program on Fisheries and Aquaculture of Sri Lanka conducted for Advanced Level Technology Stream students, 14th and 21st July 2017, Gannodaya Maha Vidyalaya, Divulapitiya.
4. Induced breeding of Koi Carp conducted for the members of Kalutara and Bandaragama Ornamental Fish Societies.
5. Ornamental fish culture and disease diagnosis for participants of Election Department, 27 April 2017.
6. Two day education program conducted for Advanced Level Technology Stream students on 14th and 21st July 2017 in Gannodaya Maha Vidyalaya, Divulapitiya.

Technical reports submitted, presentations made and short communications

Reports

1. Reports and database prepared for the PRDS consultancy project
2. Condition and its water pollution condition in the moat at Sri Dalada Maligawa in Kandy, submitted to Urban Development Authority of Central province.
3. Effect of Proposed Saltern on Fisheries in Keerathive, Jaffna, submitted.
4. Effect on *Labeo fisheri* due to proposed Moragolla Hydropower Project, submitted to CEB.
5. Evaluate the aquaculture potential of Negombo lagoon under the Five Lagoon Development project of NARA.
6. Field inspection reports on Recommendations for using government lands for agriculture and crab farming activities for private owners with four relevant letters.
7. Integrated mangrove-mixed aquaculture park for the development of small holder rural aquaculture at RRC Kalpitiya, submitted to NARA.
8. Reports on seacucmber survey and Formation and training of surveillance group for BRMS, Kalpitiya (Project Component 3.1 and 2.2 of CENARA PHASE 2) submitted to FAO
9. Project terminal report of FAO/TCP/ 3502
10. Research and Infra-structure plan for NARA Regional Research Center Kalpitiya, submitted to NARA
11. Reviews & Data Gaps of Sea cucumber Researches in Sri Lanka, submitted to
12. Studies of Sensitive Coastal Habitats of Sea cucumbers
13. Value addition of Sea cucumbers, submitted to DFARD
14. Attempt on spatial planning of Aquaculturein Trincomalee Bay and adjacent waters submitted to Ministry of Fisheries
15. Reports on site suitability for aquaculture development in Puttalam district

Plan prepared for new developments

1. Plan layout for proposed “Multi species hatchery” of NARA at Kandakuliya, Kudawa.
2. Green house for plant culture
3. Freshwater and marine research facility exacting higher standards

Short communication

1. NARA observations and recommendations for Sustainable Energy Development Project, Ministry of Power and Renewable Energy.
2. NARA feed back to develop Blue Economy Needs in SAARC Region Countries.

Project proposal developed, implemented and other distinct particulars

1. Four hundred twenty (420) million cost project proposal to establish a "Mud crab hatchery" seeking fund from ADB, submitted to Ministry of Primary Industries in 2017.
2. Six hundred (600) million project proposal developed to establish a "Multi-species Mariculture Hatchery in Kalpitiya", and submitted to Ministry of Fisheries and Aquatic Resources Development seeking the budget from Treasury.
3. (Division (P.A.D.A. Kumara, Senior Scientist) has taken sole responsibilities in coordinating activities related to acquiring land to establish a proposed "Multi-Species Hatchery" for NARA at Kudawa, Kalpitiya area. This included development of the project proposal, concept paper, obtaining legal clearance and approvals from the relevant agencies, land demarcation, preparation of lay out plan, identification of construction components, assist in seeking funds and hiring of consultants. Now the work is in progress).
4. Establish "Multi-species mariculture venture for NARA", submitted to Kalpitiya Divisional Secretariat.
5. Four proposals for community based projects

Undergraduate students supervised

1. Manoja Priyadharshani, B. Sc Agriculture student, under the topic of "Diversity, Distribution and Identification of Bivalves in Rekawa lagoon in Sri Lanka" (2017), Faculty of Agriculture, University of Jaffna (2017).
2. R. Srikrishnan, M. Phil studies on "Impact of salinity on the mangroves and mangrove benthos in Rekawa lagoon" 2016/2017.
3. Research projects of B.Sc. in Agriculture and Animal Health students of University of Peradeniya.
4. Two undergraduates were supervised on "Effects of Chitosan on survival and growth performances of Tiger shrimp (*Penaeous monodon*)" and "Effects of brewers' yeast on growth performances of juvenile sea cucumber (*Holothuria scabra*)".
5. Research project of Development of optimum conditions for inducing release of swarmers in *Ulva lactuca,* Animal Science Degree Programme, Department of Animal Science, Faculty of Animal Science and Export Agriculture UvaWellassa University of Sri Lanka
6. Study on impacts of substrates and shade on optimum growth of micro-propagated *Cryptocoryne wendtii,* Animal Science Degree Programme, Department of Animal Science, Faculty of Animal Science and Export Agriculture UvaWellassa University of Sri Lanka

7. Study on, Effect of fertilization rates on the growth performance of micro-propagated (tissue cultured) *Cryptocoryne wendtii*, Department of Fisheries and Aquaculture, Faculty of Fisheries and Marine Sciences and Technology, University of Ruhuna

Trainings/ workshops/ seminars attended
Foreign trainings /workshops/Conference

1. Workshop on "Grouper seed production and health management", Situbondo, Indonesia from 21st to 28th November 2017.
2. Workshop on SAARC Regional Expert Consultation on Best Management Practices in Capacity Building and Policy Development, from 19th to 21st September in Negombo, Sri Lanka
3. Seminar on aquatic animal health management and quarantine for countries along the maritime silk road, Wuxi China
4. ESCA 2017 conference from 16-20 October, Shanghi, China
5. Training on Sustainable and intensive aquaculture for Asian countries in Wuxi, China
6. Training on Mariculture Aqua feed production and Disease control and prevention for developing countries
7. Training on Tilapia Breeding and high yield farming techniques for developing countries from 10th May to 18th July 2017 in China
8. Training on Fish seed production and feed development for developing countries.

Local Trainings

1. Training program on Histopathology, Faculty of Veterinary, University of Peradeniya, 17- 21 July 2017, Kandy, Sri Lanka.
2. Training on tissue culture techniques at Plant Virus Indexing Center, Homagama

Local Seminars/ workshops/conferences:

1. Ornamental fish trade and technology conference, 08 - 09 Feb.2017, Kingsbury Hotel, Colombo (organized by EDB).
2. SLAFAR Annual Scientific Session, 26th May 2017, NARA Auditorium, Colombo.
3. Symposium on sustainable development of blue green economy, Marine pollution prevention authority,
4. Biodiversity Finance Imitative (BIOFIN) organized by Ministry of Mahaweli Development and Environment, Colombo in September.

5. Conventional Wisdom on Climate effect on Agro Ecosystem, organized by Climate Adaptation project of Ministry of Mahaweli and Environment, Oct. 2017, BMICH,
6. Green Lanka program on Climate adaptation, organized by Climate Change Division of Ministry of Mahaweli and Environment, BMICH,
7. National Biodiversity Strategic Action Plan "NBSAP' organized by Ministry of Mahaweli Development and Environment, 12 September, Colombo.
8. Preparation on Kalpitiya urban development plan for 2017, organized by Urban Development Authority.
9. SAARC regional expert consultation meeting on Best Management Practices in Aquaculture Capacity development and Policy development, In Negombo

MARINE BIOLOGICAL RESOURCES DIVISION









5.5 MARINE BIOLOGICAL RESOURCES DIVISION

Head of the Division: Dr. Sisira Haputhantri

Overview of the year

The Marine Biological Resources Division (MBRD) research staff consists of 16 Scientists, 2 Development Officers, 7 Research Assistants and 10 Field Research Assistants.

The Marine Biological Resources Division (MBRD) is responsible for carrying out research towards management, development and conservation of marine living resources. 13 treasury funded research projects were carried out by MBRD in 2017. Apart from the treasury funded projects, MBRD carried out several external funded projects and consultancy work. The research programmes carried out by the division include,

- Management oriented research projects assessing the fish, crustacean and gastropod resources.
- Development oriented research projects assessing the viability of under exploited and unexploited fisheries resources
- Conservation of coral reefs threatened marine fauna.
- Species identification and population studies using molecular methods for conservation and management of marine species

MBRD attended to a number of activities in advisory and consultative capacities. More importantly, MBRD responded to a number of requests made by the Ministry of Fisheries and Aquatic Resources Development (MFARD) and the Department of Fisheries and Aquatic Resources (DFAR) by providing recommendations to resolve problems on the exploitation of marine fishery resources.

On court orders, a number of fish samples were analysed by MBRD to determine whether the fish samples provided were killed by using explosives or not. In addition to this, the MBRD research staff got involved in the inspection of dynamited fish samples at the Peliyagoda fish market and inspection tours were made in collaboration with Department of Fisheries and Aquatic Resources Development (DFAR) and Sri Lanka Police. The MBRD staff also appeared at several Magistrates' Courts in order to provide experts' evidences regarding dynamite cases handled by the Police and DFAR.

The staff of the division was quite interactive with the fishing community throughout the island and also supported the private sector by attending to requests made by them. The division provided facilities and guidance to university students in undertaking industrial training and final year research projects and to school pupils to carry out their research projects. In addition, the division conducted a number of lectures and awareness programmes especially for Sri Lanka Coast Guards, Sri Lanka Navy, and for the fishing community.

The research staff of MBRD was actively engaged in updating the large pelagic and small pelagic fishery databases, analysing the statistics, providing national statistics on large pelagic fish production and preparing research papers on trends and prospects of large pelagic and small pelagic fisheries in Sri Lanka. Several reports were also prepared and submitted to the Department of Fisheries and Aquatic Resources for settling fishing disputes. The preparation of the annual research

publication of MBRD named 'Blue Ocean' was started in 2017. This research magazine was prepared based on information and results acquired by the research projects carried out by the division. Relevant data and statistics collected by MBRD during a long period of time were considered when preparing some sections in this publication. Hereafter, this will be prepared and printed as an annual publication of NARA. This product was disseminated among the stakeholders with the aim of enabling them to use relevant information / results for the management, development and conservation of marine living resources in Sri Lanka.

Major treasury funded projects carried out by MBRD

No	Title	Amount in million LKR
1	Assessment and monitoring of small pelagic, large pelagic and demersal fishery resources in Sri Lanka	6.8
2	Bio –physical and socio economic monitoring of selected coral reef ecosystems in Sri Lanka	1.9
3	Conservation of Endanger, Threatened and Protected (ETP) marine fauna in Sri Lanka and museum development	1.4
4	Stock assessment of fishery resources (Independent survey) in collaboration with Norway	14.0
Total		24.1

Sub projects /activities

Project 1

No	Sub project/ activity	Responsible Officer	Amount in million LKR
1.1.1	Assessment and monitoring of small pelagic and large pelagic fishery resources via port sampling	Dr. Sisira Haputhantri	2.2
1.1.2	Assessment and monitoring of export oriented marine fishery resources in the Northern Waters	Ms. Sujeewa Athukoorala	0.3
1.1.3	Fishery and biological aspects of Manta Ray	Dr. Chintha Perera	0.2
1.1.4	Socio-economic, biological and fisheries aspects of beach seine fishery	Mr. Mahendra Jayathilake	0.3
1.1.5	Octopus fishery development in Sri Lanka	Mr. Madura Weerasekara	1.0
1.1.6	Experiment on in situ conservation of berried spiny lobsters in south coast	Mr. Upul Liyanage	0.3
1.1.7	Molecular and biological studies on common neritic tuna species found in Sri Lanka waters	Ms. Deishini Herath	2.3
1.1.8	Gillnet selection of major small pelagic fish species in relation to size at maturity in the West Coast Gillnet Fishery	Dr. Prabath Jayasinghe	0.2

Project 2

No	Sub project/ activity	Responsible Officer	Amount in million LKR
2.3.1	Bio-physical & socio-economic monitoring of the impacts due to coral bleaching and anthropogenic activities at three selected sites	Mr. K.G.S. Nirbada	1.5
2.3.2	Biological and fisheries aspects of selected reef fishes	Mr. Kasun Dalpathadu	0.4

Project 3

No	Sub project/ activity	Responsible Officer	Amount in million LKR
5.1.1	Gear and seasonal effects on entanglement of sea turtles	Mr. Mahendra Jayathilake	0.2
5.1.2	Study the spatial and temporal distribution and abundance of Whales for conservation and management	Mr. Upul Liyanage	0.9
5.1.3	Marine museum upgrade and skeleton preparation	Mr. K.G.S. Nirbadha	0.3

Project 4

Stock assessment of fishery resources (Independent survey) in collaboration with Norway

Project no	Title
1.2_WP1	Upgrading coastal fisheries sampling programmes and data management
1.2_WP2	Technical assistance and competence building, fisheries research
1.2_WP3	Project coordination, administration and reporting.

Other treasury projects conducted by MBRD in collaboration with other divisions of NARA

Project no	Title
5.4	Identification of the Post Operational Impacts of Norochcholai Coal Power Plant
1.17	Conservation and Management of Aquatic Environment: Development of Environmental Profile to Lagoons in Sri Lanka

PROJECT NO : 1

ASSESSMENT AND MONITORING OF SMALL PELAGIC, LARGE PELAGIC AND DEMERSAL FISHERY RESOURCES IN SRI LANKA

PROJECT NO : 1.1.1

ASSESSMENT AND MONITORING OF SMALL PELAGIC AND LARGE PELAGIC FISHERY RESOURCES VIA PORT SAMPLING

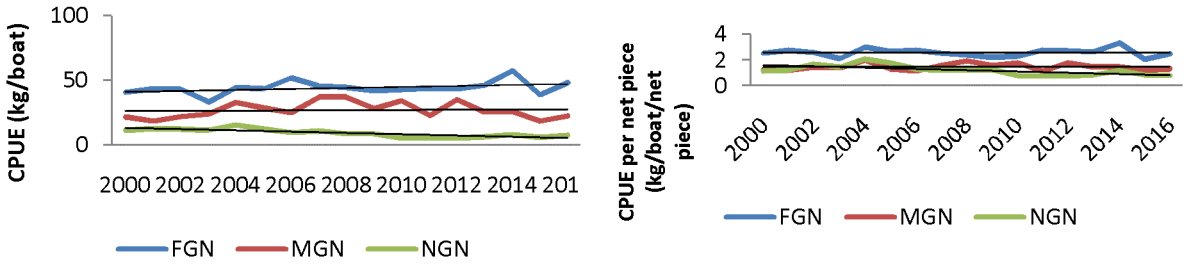
Small Pelagic Fishery

Small pelagic fish landings were monitored at fishery harbours and major fish landing sites in the western, southern and the eastern coasts of Sri Lanka. This includes collecting information such as details on fishing operations, recording the quantity of the landings by species and by different fishing vessel-gear combinations, measuring the lengths of key species and reporting the active fishing boats operated.

The small pelagic group represents over sixty marine species found in Sri Lankan waters, but, key target species in the fishery includes sardines, herrings, anchovies and mackerels. The small scale artisanal fishermen mostly operate targeting small pelagic fish species. Small mesh gillnet has been the widely used fishing gear for catching small pelagic species while Beach seines are operated seasonally. However, surrounding net fishing operations have emerged in a few areas of the country (e.g. small purse seine fishing operations ("Surukku") in Mannar District) for catching small pelagic fish in large quantities.

In small mesh gillnet fishery, the smallest mesh size (5/8" or 15.8mm) is commonly used for catching small fishes such as anchovies. Mesh sizes ranging from 15.8mm to 38mm are commonly used for catching small pelagic species. As per the research carried out by MBRD so far, it seems that the small pelagic fishery is operated at present in Sri Lanka in an unsustainable manner. Use of smaller mesh size gillnets for fishing operations, use of higher number of gillnet pieces per single fishing operation, catching of berried females of herrings during the night fishing ("Sekkal" fishery), operating a large number of fishing boats targeting small pelagic fish and extensive use of illegal fishing methods such as using dynamite are mainly responsible for the prevailing unsustainable nature of key small pelagic fish stocks in Sri Lanka.

The annual average of Catch Per Unit Effort (CPUE) in terms of total catch per boat per operation of non-motorized traditional crafts operated with small mesh gillnets (NGN) has clearly dropped over the 2000-2016 period (Figure 1). The same average CPUE estimated for OFRP boats and traditional motorized boats operated with small mesh gillnets (FGN and MGN respectively) have a slight increasing trend but, if CPUE was estimated in terms of catch per boat per net piece then it would not be seen as an increasing trend (Figure 1).



(a) (b)

Figure 1. Annual average of Catch Per Unit Effort (CPUE) (a) in terms of average total catch in Kilogram per boat per fishing operation (b) in terms of average total catch in Kilogram per gillnet piece per boat per fishing operation of non-motorized traditional crafts operated with small mesh gillnets (NGN), motorized traditional crafts operated with small mesh gillnets (MGN) and (c) outboard engine fiber reinforced plastic boats operated with small mesh gillnets (FGN)

Also, as the catch composition analysis conducted for small mesh gillnets at different periods (2000-2005, 2006 -2010 and 2011 -2017) indicated that percentage contributions of the dominant species Herrings (*Amblygaster sirm*) and Sardines, (*Sardinella* sp.) have significantly dropped (Figure 2).

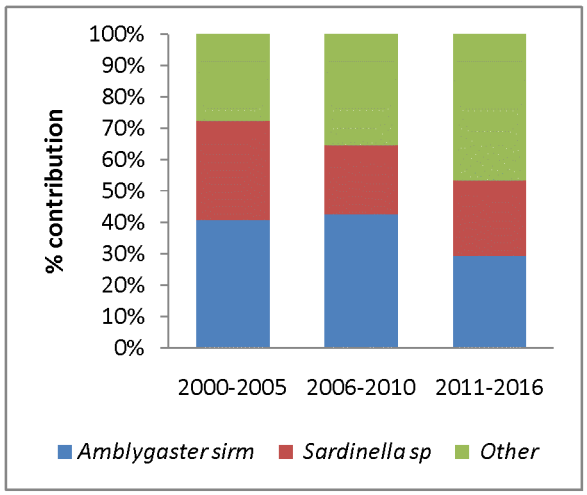


Figure 2. Catch composition of small mesh gillnets at three different time periods: 2000-2005, 2006 -2010 and 2011 -2017

It an be concluded from the above results that fishermen engaged in small mesh gillnet fishery use different tactics to maintain their catches brought to the port, sometimes by increasing the net panels, targeting different species including catching of low value species or probably following other methods such as using other gears with small mesh gillnets for the same fishing operation (use of gillnets of multiple mesh sizes or employing other gears such as handlines as a supplementary gear). At least some of these signs appearing in the resource exploitation could be considered as evidence for the resource depletion of key small pelagic species.

Recommendations proposed include reduction of fishing effort on small pelagic fish resources, controling the number of gillnet panels taken for fishing, banning of night fishing during spawning seasons and encouraging fishermen to catch other varieties in addition to herrings.

Large Pelagic Fishery

Port sampling and fisheries statistics

Large Pelagic Port sampling is a collaborative fisheries data collection programme implemented by the Marine Biological Resources Division (MBRD) of NARA, Department of Fisheries and Aquatic Resources (DFAR) and Statistics Unit of Ministry of Fisheries and Aquatic Resources Development (MFARD) for obtaining large pelagic fish landing data. Large pelagic resources mainly comprise of tuna and tuna-like species. The large pelagic port sampling survey in Sri Lanka was started in the 1990's by NARA. The main objective of the survey was to obtain catch and effort data on large pelagic fish, in particular on tuna and tuna-like fish.

IOTC data submission and attending for working parties organized by IOTC

Currently, it is a mandatory requirement to submit large pelagic fisheries data to the Indian Ocean Tuna Commission (IOTC). The data collected annually via the port sampling programme needs to be analyzed and then submitted to the IOTC before 30th June. The data submitting to IOTC needs to comply with the relevant resolutions implemented by IOTC. In the submission, catch data, effort data, length frequency data, information on discards and vessel information etc are provided in detail as per the requirements of those resolutions. As a result of complying with the resolutions relating to data submission, Sri Lanka has been able to achieve a 77% compliance rate at present. This is a great achievement when compared to our past records and compliance records of other coastal states in the Indian Ocean.

IOTC organizes several working parties and these are conducted annually. The Working Parties generally consists of scientists attending in their individual capacity and not representing any particular Contracting Party or Cooperating Non-Contracting Party (CPC). Their meetings are open to all interested scientists with expertise in the relevant issues under the Working Party consideration. The most common objective of the working party is to provide the IOTC Scientific Committee with analyses of the current status of the relevant fish stocks as well as an evaluation of possible management actions. Some Working Parties are established with the purpose of analyzing and producing recommendations on a specific technical problem.

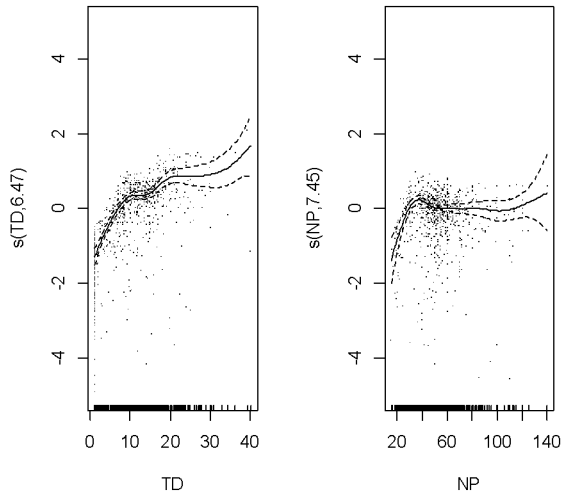
In 2017, Four MBRD scientists participated for four working party meetings. They prepared working party papers and presented at the respective working parties.

Titles and abstracts of papers presented

1. Relationship between skipjack tuna *(Katsuwonus pelamis)* Catch Per Unit Effort (CPUE) and fishing operation related parameters: A case study conducted in gillnet fishery of Sri Lanka

The fishing operations in tuna fishery of Sri Lanka are conducted by single day and multiday fishing crafts and fishing activities take place from coastal waters up to the high seas. Gillnet is the main fishing gear used in tuna fishery of Sri Lanka. Mostly multiday fishing boats use this fishing gear. Gillnet is sometimes operated as a supplementary fishing gear in longline fishery. The popular gear combinations operated with gillnets are gillnet-longline (GL), gilllnet-handline (GH) and gillnet-ringnet (GR). The key target species in gillnet fishery is skipjack tuna (*Katsuwonus pelamis*). Skipjack tuna landed by Sri Lankan fishing vessels were monitored from January 2005 – December 2017 at the major tuna landing sites and fishery harbours in Sri Lanka. The unloaded skipjack tuna catch by

the vessels was recorded. Other parameters in relation to fishing operations were also recorded: boat type, gear type, trip duration and number of net panels used. A Gamma based Generalized Additive Model (GAM) was fitted using log link function to describe the relationship between skipjack tuna CPUE and fishing operation related parameters. The fitted GAM model explains 75.4% of the deviance. Catch rates of skipjack tuna increased in association with increases in trip duration and increases in gillnet panels. Results from this case study can have few management implications.

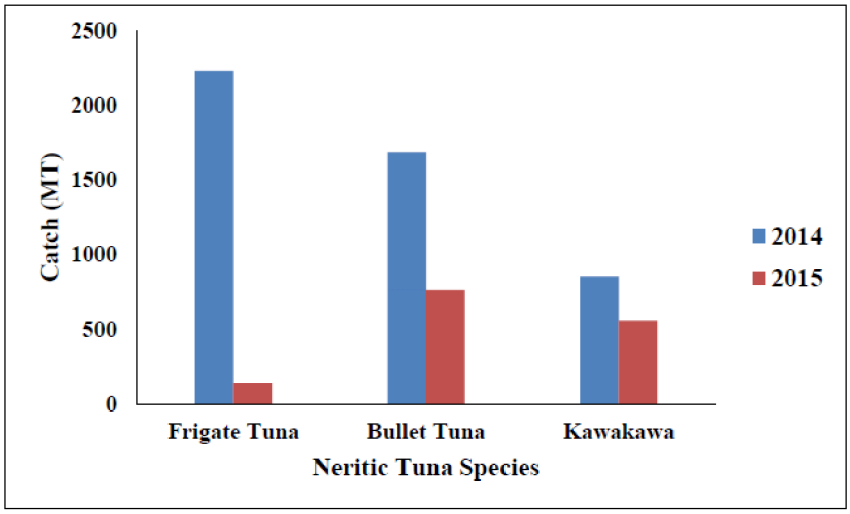


Modeled effect of trip duration (TD) and net panels used (NP) on non-zero CPUE of skipjack tuna. The solid line shows the fitted GAM function and the black-dotted line indicates 95 % confidence intervals. Relative density of data points are indicated by the rug plot on the x-axis

2. Neritic Tuna Catch, Species composition and monthly average landings in Sri Lankan Tuna Gillnet Fishery operated within EEZ

Sri Lanka is one of the most important tuna fish producing island nations in the Indian Ocean. Of the tuna; neritic tuna namely *Euthynnus affinis* (kawakawa), *Auxis rochei* (bullet tuna) and *A. thazard* (frigate tuna) are only targeted seasonally by coastal fishing crafts operated in the country. However, multiday tuna gillnet boat operations catch neritic tuna while they target oceanic tuna viz. yellowfin and skipjack tuna.

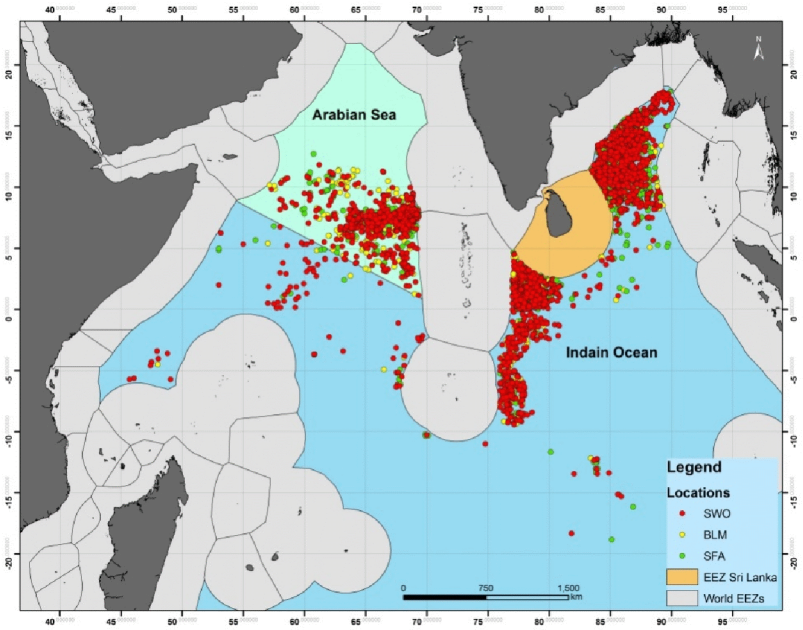
Today gillnet has become the key fishing gear in the multiday tuna fishery within and beyond EEZ and has firmly been established as the dominant gear and made neritic tuna as a non-target group. Consequently in 2014 and 2015 the percentage catch amounts of neritic tuna in the gill nets within EEZ were 55 and 34 respetively. Of the neritic tuna, bullet tuna averagely contributes 39% while frigate tuna contributes 38% and Kawakawa contributes 23%. Relatively higher amounts of bullet tuna in the gill net catches may result from multiple reasons such as stock status and seasonality. Fluctuations in monthly average landings for three different species during 2014 to 2015 could be the result of reduction of gillnet fishing pressure within EEZ of Sri Lankan waters or potential decreases in the abundance of resources in the tuna fishing grounds.



Total neritic tuna catch composition of gillnet within EEZ in multiday tuna fishery in Sri Lanka during 2014- 2015

3. Exploring the spatial distribution to analyze the spatial variability of catch compositions of three major billfish species; Sword fish (*Xiphias gladius*), Black marlin (*Makaira indica*) and Sail fish (*Istiophorus platypterus*) from high seas multi-day fishery in Sri Lanka

Of the five major billfish species in local commercial landings, black marlin (Makaira indica), sailfish (Istiophorus platypterus) and swordfish (Xiphias gladius) are dominant in terms of their contribution to the total national production. There is a lack of studies focused to explore their spatial distribution in order to analyze the spatial variability of catch compositions. Therefore, this study aimed to address it using 2016 logbook data and related spatial information. The spatial distribution of three bill fish species; sword fish (SWO), black marlin (BLM) and sailfish (SFA) was mapped at 05 grid resolutions. Spatial variability of catch compositions was analyzed and compared among the three billfish species. Generally, the spatial distribution of billfish species resulted in three distinct spatial clusters as Bay of Bengal spatial cluster (BB), Arabian Sea-Indian Ocean spatial cluster (ASIO) and Indian Ocean spatial cluster (IO), directing along the EEZ boundary of Maldives from the Southwest EEZ boundary of Sri Lanka. Geographically, the spatial areas were identified as 7 0 -17 0 N, 75-80E; 10 0 S-5 0 N, 75 0 -80 0 E; 55 0 -70 0 E, 0 0 -15 0 N respectively for BB, IO and ASIO. The percentage catch contributions were 49 %, 29 % and 21 % respectively for ASIO, BB and IO. Within each spatial cluster, SWO showed highest contribution to the total catch. It contributed 56 % and 45 %respectively for ASIO and IO spatial clusters while 40 % for the BB, where it equals to the SFA. Even though BLM dominated in the IO (43 %) and ASIO (33 %), it was dominated by SFA (40%) in the BB. SFA showed highest spatial variability while SWO showed the lowest. It can be concluded that the spatial distribution of selected billfish species from the high sea multi-day fishery in Sri Lanka is quite distinct with clustered spatial pattern. This distinct spatial distribution together with catch variability provides a glimpse of habitat preference of billfish species facilitating the fishing operations. Further, the ASIO is the most preferred spatial area for SWO while BB and IO respectively for SFA and BLM. But the spatial variability of catch compositions can vary due to the gear combinations used and their frequency of operation.



Spatial distribution of three major billfish species in high sea fishing in 2016

Progress : Physical: % Financial:

PROJECT NO : 1.1.2

ASSESSMENT AND MONITORING OF EXPORT ORIENTED MARINE FISHERY RESOURCES IN THE NORTHERN WATERS

Fisheries industry is one of the major export industries which contribute significantly to the Sri Lankan economy. Among those, lobster, sea cucumber, chank, marine ornamental fish, shrimps and blue swimming crab play a significant role in the Sri Lankan fisheries export market due to the high value of the commodities. Among these resources sea cucumbers, chank, ornamental fish and lobsters are manually collected by the divers. The respective fishing operations are entirely affected by monsoons and fishing operations could be carried out only under the calm sea conditions,. For fishing operations, divers should have valid fishing operation licenses issued by Department of Fisheries and Aquatic Resources (DFAR). For catching blue swimming crabs, gillnets are widely used. At present, above resources are heavily exploited due to the high demand in the export market. The aim of this project was to find out the current status of the resources in the northern waters of Sri Lanka. Since conducting of fishery independent surveys is costly the fishery dependent data was considered.

Data were mainly collected by interviewing fishermen and using the log books maintain by them during the field visits made by the study team to the respective landing sites once in a month. Some of other data were collected from Assistant Directors of DFAR in respective fisheries districts.

Mullaithivu district

Mullaithivu district is famous for sea cucumber fishery. Currently there are 297 permit holders for sea cucumber and chank fishing. According to the catch data, the *Bohadschia marmorata* which is

locally called kiri nool attaya is the most prominent species followed by *Holothuria spinifera* (disco attaya/vali attaya). *Actinopyga miliaris* (Kalugal attaya), *Bohadschia vitiensis* (Duburunool) and *Thelenota anax* (Poona attaya) were recorded in very small quantities. According to the size category of *B. marmorata* species, medium and small size categories are mostly harvested. In July, the catch has peaked. In May and August the catches were also higher. *H. spinifera* is prominent in the night catches while *B. marmorata* harvest is equal in both night and day catches



A B C

Figure: (A) sea cucumber harvest (B) sorting of individuals according to the length of their body (C) women are engaged in gutting process

A small quantity of chanks is also found among the sea cucumber catches. The average catch of sea cucumbers per boat per day was 2.8 individuals during the survey period. There were no registered fishermen for lobsters and the crab fishing was scattered along the lagoons and there is no coastal fishery for crabs in Mullaithivu district. Sometimes crabs come as a by catch in gillnet fishery but it is a very small in quantity. During the survey, 14 ornamental fish species belonging to 10 families were also recorded.

Jaffna district

Sea cucumber, chank, ornamental fish and lobster fishery for year 2017, DFAR had not issued diving licenses in Jaffna district. Therefore, no fishing operations were carried out targeting above species.

Blue swimming crab fishery

Jaffna coast is very famous for the blue swimming crab fishery. The catch has peaked in February and November.

Kilinochchi and Mannar districts

Scuba diving is not frequently practiced in Kilinochchi district but skin diving is mostly done for catching sea cucumbers. However, fishing operations had started in November in both Kilinocchi and Mannar districts.

Based on the results under the study, few recommendations were also proposed to DFAR for sustainable utilization of these important resources.

Progress : Physical : 100 % Financial:

PROJECT NO : 1.1.3

FISHERY AND BIOLOGICAL ASPECTS OF MANTA RAY

Manta rays are fish and are closely related to sharks, skates, and other rays which are collectively known as elasmobranchs because they have skeletons made of cartilage instead of bone. Manta ray is the common term for two species of rays: *Manta birostris*, the giant manta/ oceanic manta ray, and the smaller *Manta alfredi*, known as the reef manta. Manta rays are in high demand in international trade markets. Fishing is the main threat to manta rays around the world. Due to their life history namely slow growth; late age of sexual maturation and low fecundity, manta populations are numerically small.

Present study was conducted in three major fish landings in Sri Lanka namely; Mirissa, Beruwala and Negombo from January to December in 2017. There is a paucity of information on Manta rays, and they are highly susceptible to fishing pressure due to their slow growth, late age at maturity and low fecundity.

Interviews conducted with the fishermen have indicated that majority of fishermen release manta rays from their entangled nets due to their large size, not being easy to kill and meat not being of much value. Moreover, if they catch manta they need more space and ice to store them, therefore it is economically more viable to catch five or six yellowfin tuna rather catching mantas. If they store them in fish holding facilities with other fish, ice melts easily. Therefore, fishermen do not like to store manta at the beginning of their fishing trip but they would like to store them when they come back to the landing sites.

Manta rays are mostly caught as a by catch in gillnet fishey (mesh size 6'' and 5 ½''). The total number of observed Mantas was 46 individuals; of the observed specimens *M. birostris* included 40 (87%) individuals, 29 females, 10 males and 1 unknown. The largest had a Disk Width (DW) of 386 cm (female) while the smallest had a DW of 118 cm (male). The average DW estimated during the study was 262.45 cm.



Manta birostris

Of the observed individuals, *M. alfredi* included 5 (13%) individuals, representing 3 males and 2 females. The largest had a DW of 197 cm (female) while the smallest had DW of 129 cm (female). The average DW found during the study was 162.6 cm. Of the observed specimens of manta, only 5% were adults while the others represent immature and sub adults. Most of the guts had been removed when they were at sea. Main food item found in manta gut was shrimps (only two guts were collected).

The skipjack tuna schools are frequently found during the months of September, October, and November (2017) around Sri Lankan waters; therefore, as fishermen caught more skipjack tuna there would have been no space to store manta rays. Of the observed specimens only 5% were adults while the others (95%) represent immature and sub adults, indicating that nursery grounds might be located close to the fishing grounds; therefore, live releasing of entangled manta rays is recommended. Also, more research needs to be conducted with the aim of finding the specific nursery/ breeding grounds of manta rays. Internal organs of the most landed manta rays had been removed; therefore, some biological studies are limited to some extent. This is the major constraint faced during the study period.

Progress : Physical : 90% Financial

PROJECT NO : 1.1.4

SOCIO-ECONOMIC, BIOLOGICAL AND FISHERIES ASPECTS OF BEACH SEINE FISHERY

The beach seine fishery is seasonal and fishing operations are mostly confined to calmer non monsoonal months of the year. Over the last three decades, beach seine fishery has been subjected to several changes with respect to the type of beach seine craft operated, materials used for the net and management/ policy decisions taken regarding beach seine fishing operations. A major change took place recently in the beach seine fishing industry due to the introduction of a winch to operate the beach seine net. This winch is becoming popular among beach seine operators since it provides an alternative solution for the growing manpower shortage for operating the beach seine net. With the introduction of the new winch, fishermen could go and operate at a greater distance from the shore than before. As a result, the fishing area is being widened and the efficiency of the gear is also being increased. Therefore, this could also lead for resource user conflicts among resource users. This study was carried out with the aim of identifying the present status of beach seine fishery in north-western coastal waters and possible impacts due to the introduction of the new winch for beach seine fishing operations in order to propose management recommendations.

The survey consisted of two parts, a frame survey and a comprehensive beach seine fishery survey. Initially, the framework survey was carried out along the coast from Pukkulam to Sindatriya with the aim of identifying the beach seine centers and operational procedures etc. Out of 173 beach seine centres, 12 centres were selected as sampling sites for the survey.

During the six month of the study period, a total of 53 species belonging to 23 families were identified among the beach seine catches. The beach seine catch comprises of *Selar crumenophthalmus* (Big eye scad -Asgedi bolla) 17%, *Stolephorus sp.(*Anchovy -Halmassa) 16%, *Sardinelle longiceps* (Indian Oil Sardine -Yak salaya) 11%, *Sardinelle albella* (White sardinella-Sudaya) 9%, *Rastrelliger kanagurta* (Indian mackerel-Kumbalawa) 8%, *Sardinelle gibbosa* (Goldstripe sardinella -Matta salaya) 6%, *Leiognathus sp.* (Ponyfish - Karalla) 5% and *Atule mate* (Yellowtail scad - Kaha parawa) 4%.

The estimated mean catch per haul for winch operation was about 286 kg while for manual operations, it was about 308 kg. With the introduction of the winch, manpower for hauling process

has been reduced whereas the gear operation time and operational area have significantly been increased. The average total length of a beach seine in the study area was 2.3 km although there were significant differences from place to place depending on the number of ropes used and the length of the beach seine net used.

Present study recommended that length of the beach seine need to be limited up to 2 km. (Too long beach seine operations may be a hindrance to other fishing activities), maximum number of beach seine operations per day should also be limited up to 2. However, it is not recommended to use hydraulic winches and tractors for hauling the beach seine till implementing a proper mechanism for monitoring the fishing operations.

Progress : Physical : 90% Financial

PROJECT NO : 1.1.5
OCTOPUS FISHERY DEVELOPMENT IN SRI LANKA

The fisheries sector plays a vital role with significant contribution to the national GDP. The Ministry of Fisheries and Aquatic Resources Development (MFARD) strives to enhance it under the concept, "Blue Economy". Exploring untapped fishery resources contributes to strengthen this concept. Based on this, as the research arm of the MFARD, NARA started the Octopus fishery development project in 2016, with the direct involvement of a Korean investor, who is in need of bringing an export market for Octopus in Sri Lanka. In 2016, a preliminary survey was carried out to identify potential fishing grounds and prospective fishing communities. The project continued in 2017 with further studies including a study on biological aspects of Octopus particularly on *Amphioctopus aegina*, a potential species recorded in Sri Lanka that could be developed aiming the export market. Further, testing a selective fishing gear for octopus was one of the major objectives of the project and its effectiveness and efficiency was tested by means of experimental fishing based on the coastal waters in the Northwestern and Northern regions of Sri Lanka.

Project Activities

- Experimental fishing with newly introduced fishing trap
- Collection of catch and effort data in the trawl fishery.
- Study on reproductive biology and molecular analysis.
- Mapping of potential fishing grounds.

Findings

- Experimental fishing resulted in an average catch rate of 17 individuals /100 traps. An increasing trend was observed in the average catch rate with the increased soaking time (Figure 2).

- February, July and October are the months associated with higher values of Gonadosomatic Index (GSI) – These peaks provide the evidence for the peak spawning seasons of *Amphioctopus aegina* (Figure 3), the confirmed species via molecular methods.

- The sex ratio between male and female was 3.8: 1. The sex ratio fluctuated highly throughout the year

- Maturity Stages: Four maturity stages were identified for Octopus: Stage I – Immature, Stage II - Maturing, Stage 3 – Mature, Stage 4 –Spawning.

- The estimated value for size at first maturity was 6.2 cm DML for male, while 5.1 cm DML for females. The estimated value for combined sexes was 6.3 cm (figure 4).

- Trawl catch analysis results show that 12 % of the total catch is represented by octopus and this value was found to be similar during the considered period, Feb-Jun, 2017 (Figure 6). The analysis was based on the catch and effort data taken from trawl fishery at Pesalai.



Figure 1. Octopus captured during trial fishing at Pukkulam

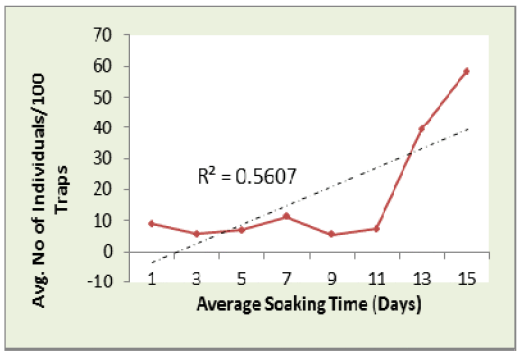


Figure 2. Variability in average catch rates at different soaking times

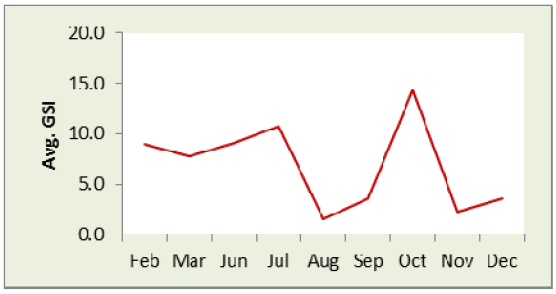


Figure 03. Seasonality of average GSI for Amphioctopus aegina

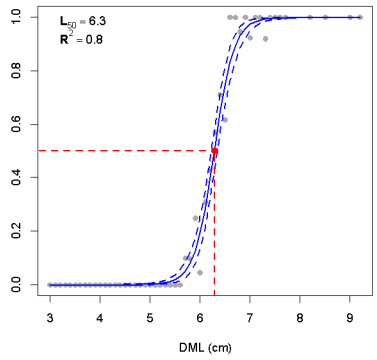


Figure 4. The graph showing DWL Vs maturity of Amphioctopus aegina

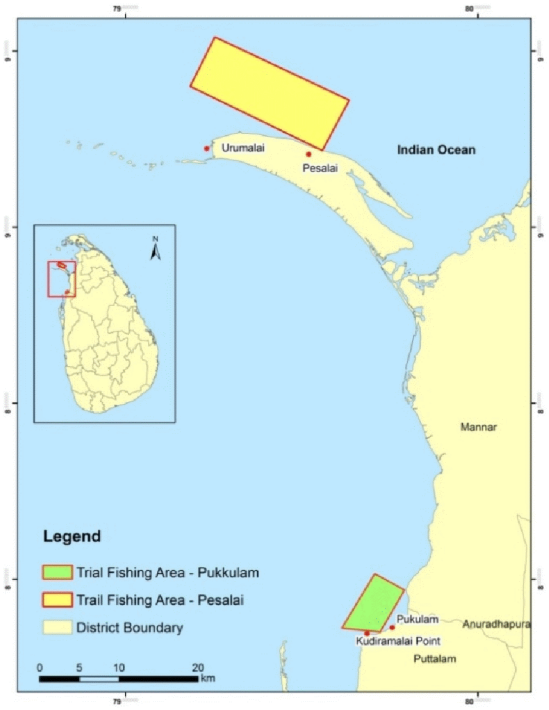


Figure 07: Map represents the area, where trial fishing was carried out using the trap (Pukkulam and Pesalai)



Figure 5. Specimen of Amphioctopus aegina

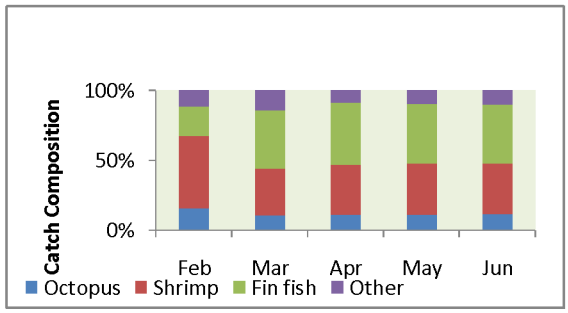


Figure 6. Seasonal variations of catch compositions of trawl catches in Pesalai, Mannar District

Recommendations

- Octopus fishery is recommended as a good alterna method particularly for small scale fishing communities.
- The best soaking time could be recommended as 15 days.
- The trap used could be highly recommended as an effective and selective fishing gear for the areas associated with sandy/muddy bottoms, where gastropods and bivalves are abundant (e.g: shrimp trawl grounds).

- It is recommended to declare closed seasons during the spawning periods when the fishery is developed at a commercial scale. During this period, traps could be used as a medium for egg deposition as already practiced in some countries like Korea.
- Further studies are recommended to be carried out for determining the spawning peaks for declaring the closed seasons.

Constraints

Placing traps inside a trawl ground is highly disturbed due to regular bottom trawling activities. It was also noticed that fishing traps could occasionally be disturbed by the routine gillnet fishing operations too.

Further Studies

- Biological Analysis
- Biomass Estimation by Experimental trawling
- Nutritional Analysis

Progress : Physical : Financial :

PROJECT NO : 1.1.6

EXPERIMENT ON IN SITU CONSERVATION OF BERRIED SPINY LOBSTERS IN SOUTH COAST

Spiny lobster fishery is an export oriented artisanal fishery popular among the small scale fishermen in the south coast of Sri Lanka. Since more than 60% of the catch is being produced by the fishermen in the South coast especially from Tangalle to Patanangala coastal stretch, the fishery is important to the Hambanthota district.

High exploitation rate followed by the continuous demand always make disturbances on the natural growth of the population reflecting declining catch rates, changes of the species composition of the catch, size disparity of the length classes and declining economic returns for an effort etc. Moreover, the recovery efforts after the tsunami may be exacerbating the problem because many new boats and gears that were donated to the local fishing communities are used for the spiny lobster fishery.

Furthermore, the Southern Coastal Lobster Regulations implemented in 2000 are not being followed by lobster fishers and exporters. Many researches revealed that female lobsters release 250,000 to 2,000,000 eggs at a spawning based on their species and body size. Majority of the lobster fishermen sell berried lobsters to the market after removing their external eggs. Egg removal of the berried females and illegal fishing during the closed season are identified as main reasons for depletion of the stock. Current research targeted to find a suitable method for conservation of berried spiny lobsters. A lobster rearing site was constructed at the sea (Kaisawella) near the Dondra lighthouse. Berried lobsters collected by the fishermen were stocked until they released their eggs. 35 lobsters released eggs under captivity (purchased and some from the fishermen).



a. Steps of construction



b. site expansion



c. Awareness programme for the Polhena fisheries committee



d. stocking of berried females

In addition to this, several awareness programmes were conducted through the CENARA project and one culture site was constructed in Polhena for the fishing community.

Progress : Physical : Financial :

PROJECT NO : 1.1.7

MOLECULAR AND BIOLOGICAL STUDIES ON THREE COMMON NERITIC TUNA SPECIES FOUND IN SRI LANKAN WATERS

Samples of the three neritic tuna species, Kawakawa (*Euthynnus affinis)*, Frigate tuna (*Auxis thazard*) and Bullet tuna (*Auxis rochei*) were collected as whole fish from the fishery harbours of Kalpitiya, Chilaw, Negombo, Beruwela, Dodanduwa, Galle, Mirissa and Trincomalee. The whole fish were transported to the laboratory on ice and stored in a freezer until analyzed. 472 Kawakawa samples, 416 Frigate tuna samples and 210 Bullet tuna samples (a total of 1098 fish samples) were collected.

Each whole fish sample was used for biological analysis as well as molecular analysis. 23 morphometric measurements (weight, total length, fork length, standard length, fin lengths etc.) were recorded for each fish in a data sheet. The fish samples were dissected to separate the organs of the body cavity. The gut was dissected to determine the stomach fullness and to identify the different food items that were present and the weight of each food type was recorded. The gonads were separated out and the weight of the gonads and the stage of maturity were recorded as F1 to F5 for females and M1 to M5 for males according to the stage of maturity. Gonads with eggs were preserved in 10% buffered formalin to count the number of eggs for the calculation of fecundity.

Muscle tissue samples of all the samples analyzed for biological parameters were preserved in alcohol for molecular analysis. The DNA of randomly selected samples of each region, were

extracted using the conventional phenol chloroform method. The extracted DNA was run on an agarose gel to determine the quality and quantity of DNA. The mitochondrial COI PCR was carried out with the universal fish identification primers (FISH-F1 and FISH-R1) and the mitochondrial D-loop region amplification was carried out with the primers 5' CCGGACGTCGGAGGTTAAAAT 3' (forward) and 5' AGGAACCAAATGCCAGGAATA 3' (reverse) for the DNA of the 3 species and these PCR products were sequenced at Macrogen Korea.

The analysis of the length frequency data revealed that the length weight relationship ($W=aL^b$) for each of the 3 species Kawakawa, Frigate and Bullet tuna were $W=0.130L^{3.124}$, $W=0.828L^{3.433}$ and $W=0.099L^{3.316}$ respectively. All 3 species showed a "b" value higher than 3, indicating an allometric growth pattern. The three species showed non-selective feeding with the major prey item being small fish (herrings, anchovies and *Sardinella* sp. and lizard fish larvae), followed by shrimp and cephalopods. In addition, a few stomachs contained stomatopod larvae, plastics debris and leaves. The gonado somatic index for the samples collected peaked in June and October for female Kawakawa and in May and July for female frigate tuna. The fecundity ranged from 245,010 to 1,805,000 for Kawakawa, 48,056 to 267,000 for frigate tuna and 22,545 to 81,692 for bullet tuna.

The mitochondrial COI region sequences (650 bp in length) identified the fish, to species level with more than 97% similarity in all cases. Phylogenetic analysis of the mitochondrial DNA D-loop region sequences (500 bp in lebgth) done for all 3 species shows that the stocks of all 3 species from the different regions of the coastal areas are of the same origin. When D-loop sequences of all 3 species were considered together, it could be inferred that frigate tuna and bullet tuna are more closely related to each other than they are to kawakawa. It also shows that out of frigate tuna (*A. thazard*) and bullet tuna (*A. rochei*), the species A. *rochei* is the ancestral species evolving before *A. thazard*.



Kawakawa (*Euthynnus affinis*) (Atawalla)



Frigate tuna (*Auxis thazard*) (Alagoduwa)



Bullet tuna (Auxis rochei) (Baita)

Progress : Physical : Financial :

PROJECT NO : 1.1.8

MATURATION AND GILLNET SELECTIVITY OF KEY SMALL PELAGIC FISH SPECIES IN THE WEST AND NORTHWEST COASTS IN SRI LANKA

Herrings and sardines comprise the majority of coastal small pelagic fish production in Sri Lanka. The coastal fisheries exploitation has shown some alarming signals as many small pelagic fish resources are being threatened. Commercial fishermen use the most efficient mesh sizes to catch different size classes ranging from juveniles to adults. In practice, the selection of catches depends upon the size rather than the age of the fish. But in good fisheries practices fishing gear should catch the large adult fish while small juveniles are allowed to escape. Because of the selective nature of gillnets, mesh size can be controlled to restrict the size of fish captured and either selection or retention curves can be used to calculate the mesh size required. Introduction of minimum mesh size regulations can be used to minimize the catch of immature fish or to reinforce minimum landing size regulations. Therefore, the objective of the study is to identify suitable mesh sizes in gillnet fishery for catching key small pelagic species, and to provide a scientific basis for advice on mesh size regulations.

The study was carried out at the major and minor landing sites in West and Northwest Coasts namely Beruwala, Negombo, Chilaw and Kandakuliya from January to December 2017. Mesh size wise length frequency data of key small pelagic fish species in small-meshed gillnet fishery was obtained at the landing sites a on monthly basis. Further, the operated depth, species recorded, total catch, number of net pieces used, time of the fishing and the total number of boats operated at the landing site were also recorded. Randomly selected samples of key small pelagic species such as *Sardinella gibosa*, *S. longiceps* and *Amblygaster sirm* were brought to the laboratory and analyzed for length, weight, sex and maturity stages. For each mesh size, the gravid (matured) and younger stages of fish were identified and the percentage of mature fish was recorded. Then for each fish species, the corresponding length at 50% maturity (L50) was determined.

The field investigations revealed that a wide range of mesh sizes such as 9/10, 1 1/16, 1 5/16, 1 3/16, 1, 1 1/8, 1 6/16, 1 7/16, 1 1/2, and 1 ¼ inch are being used for catching small pelagics. *Amblygaster sirm* and *Sardinella* sp dominated by *S. gibbosa* contributed more than 80% to the fish catch.

The length at 50% maturity of *A. sirm* was recorded in the size class of 15-16 cm and for *S. gibbossa* and *S. longiceps*, the respective values were between 12-13cm. Accordingly the length frequency distribution of key species indicated that gillnets of 1 1/16" and below harvest immature fish of *A. sirm* in high frequencies, while the gillnets with 1" and below this mesh size catch a higher number of immature *Sardinella* sp.

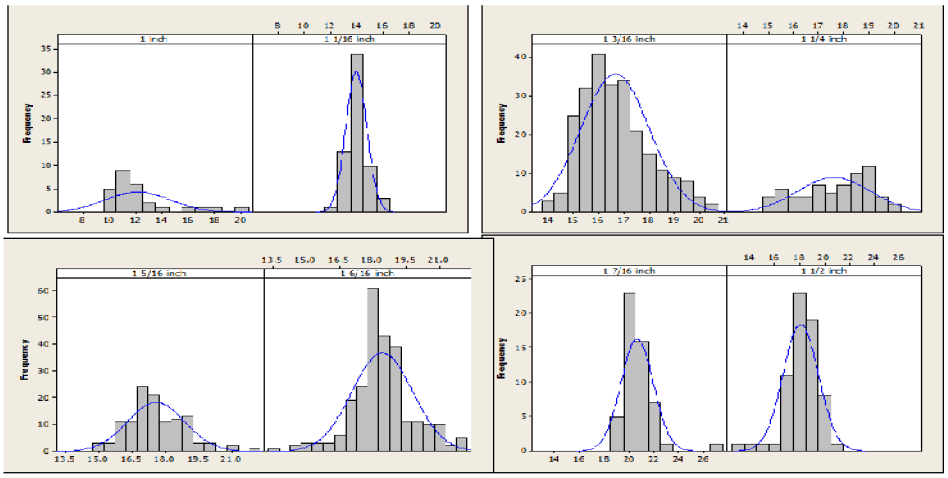


Figure 1: Length frequency distribution of *A. sirm* for different mesh sizes.

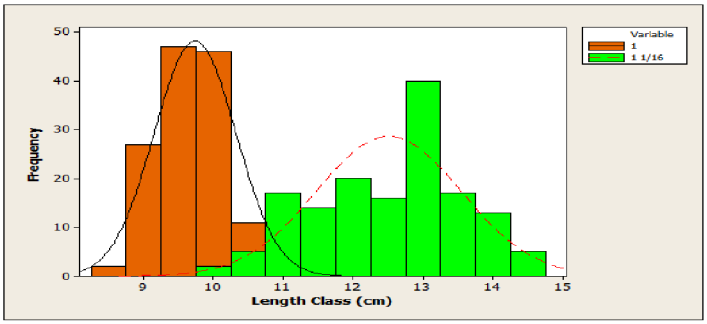


Figure 2: Length frequency distribution of Sardinella sp for different mesh sizes.

Therefore, it is recommended to control the use of mesh sizes of 1 1/16" and below when targeting *A. sirm*. Similarly, it is suggested to control the use of gillnets of 1" or below 1" for catching *Sardinella* sp. After taking in to the consideration of the practical situation, it is advisable to control the mesh size of 1 or below 1 in small pelagic fishery for caching all small pelagic species except anchovies.

Progress : Physical: Financial

PROJECT NO : 2

BIO – PHYSICAL AND SOCIO ECONOMIC MONITORING OF SELECTED CORAL REEF ECOSYSTEMS IN SRI LANKA

PROJECT NO : 2.3.1

BIO-PHYSICAL & SOCIO-ECONOMIC MONITORING OF THE IMPACTS DUE TO CORAL BLEACHING AND ANTHROPOGENIC ACTIVITIES AT THREE SELECTED SITES

Coral reefs are biologically valuable ecosystems in the globe and rank among the most biologically productive and diverse of all natural ecosystems. A single reef can be home to 3,000 different species, while one third of the world's fish species depend on them. They calm the energy of the waves, providing vital protection to shores. For centuries coral reefs have been a valuable resource

for the people of Sri Lanka, in particular for the coastal communities. Coral reefs are rich in biodiversity and are important as habitats for flora and fauna, for containing coastal erosion, and for sustaining the coastal fishery. There are three types of coral reefs in Sri Lanka i.e. Fringing (Hikkaduwa); Apron (found on rocky substrates near shore); and barrier (Vankalai and Silavathurai). Sri Lanka has well-developed reefs, but the majority are of sandstone and rock, and boulder reeks are common along the southern and eastern coasts. In contrast, the extent of true coral reefs is limited: only about two per cent of the coastline has fringing coral reefs (mostly along the southwestern, southern and eastern coasts) but off-shore patch reefs are more extensive.

Hikkaduwa and Pigeon Island National parks (two marine national parks in Sri Lanka) and Bar reef marine sanctuary were selected as study sites to monitor, bio physical and socio economic impacts due to coral bleaching and anthropogenic activities. Hikkaduwa National Park (area 101.6 hectares and declared in year 2002) in southern coast covers a coastline of approximately 1.35 km between the southern breakwater of the Hikkaduwa fisheries harbour and rocky islets near the Coral Gardens Hotel. The Pigeon Island national park (declared in year 2003) is situated 1 km off the coast of Nilaveli, a coastal town in Eastern Province, encompassing a total area of 471.4 hectares. The Bar Reef, which was declared as a Marine Sanctuary in 1992, is located west of Kalpitiya peninsula. The extent of the sanctuary is 30669.9 hectares. The landward boundary borders the northern section of Kalpitiya peninsula and Karathivu island to the north.

The Percentage cover of corals, species composition, newly settled coral, coral bleaching percentage and composition and diversity of associated fauna and flora were assessed. For this, manta tow survey, 100 m line transect survey, 50 m point intercept transect method, quadrate (1 m X 0.5 m) sampling, video transect method and photo transect method were employed. Point intercept transects of 50 m length were deployed in Hikkaduwa and Pigeon Island (Trincomalee) national parks snorkeling area between 3 and 5 m depth, and following benthic cover categories were recorded accordingly: live hard coral (HC), dead hard coral (DC), bleached coral (BC), newly settled/ developing coral buds (CN), soft coral (SC), sponge (SP), Algae (AG), coral rubbles (CR), rock substrate (RC), sand stone substrate (SS), sand (SD), silt (SL), seaweeds (SW), seagrasses (SG), other biota (OB) and other artificial objects (OO). Physical parameters monitored included depth, bathymetry, reef profile, temperature, visibility, and salinity. Community populations, employment levels and incomes, proportion of fisheries, catch and price statistics for reef fisheries and community perceptions of reef management were examined under the socio economic study.

Forty two coral species belonging to 20 genera and 12 families were recorded from the three sites. Fourteen species belonged to Merulinidae family (14). Other families which represented several species were Acroporidae (08), Lobophyllidae (04), Agaricidae (03) and Pocilloporidae (03). The coral species of *Acropora muricata* (Linnaeus, 1758), *Pavona minuta* (Wells, 1954), *Lobophyllia radians* (Milne Edwards & Haime, 1849), *Lobophyllia recta* (Dana, 1846), *Pocillopora damicornis* (Linnaeus, 1758), *Pocillopora grandis* (Dana, 1846) and *Pocillopora verrucosa* (Ellis and Solander, 1786) were recorded from all three sites. Highest abundance of coral species was recorded from Pigeon Island in Trincomalee whereas the highest diversity of coral species with lowest abundance was recorded from Hikkaduva marine sanctuary. Most *Acropora sp.* colonies found in Bar Reef Marine Sanctuary were totally degraded. Most of the shallow areas (3-4m) in this sanctuary were dominated by sea weed species.

Eighty-one (81) species of reef fish belonging to 45 genera and 23 families were recorded from three selected sites. Highest abundance of reef fish and diversity were recorded from Pigeon Island in Trincomalee and the lowest was recorded from Hikkaduva marine sanctuary. Fifteen species belonged to Labridae. Other families which comprised of several species were Pomacentridae (10), Chaetodontidae (07), Acanthuridae (06), Lutjanidae (06), Balistridae(05) and Scaridae (05) (Table 03). The reef fish species of *Acanthurus lineatus* (Linnaeus, 1758) (Lined surgeonfish), *Acanthurus triostegus* (Linnaeus, 1758) (Convict surgeonfish), *Balistapus undulatus* (Park, 1797) (Orange-lined triggerfish), *Plectorhinchus vittatus* (Linnaeus, 1758) (Indian Ocean oriental sweetlips), *Gomphosus caeruleus* (Lacepède, 1801) (Indian Ocean bird wrasse), *Halichoeres nebulosus* (Valenciennes, 1839) (Nebulous wrasse), *Labroides dimidiatus* (Valenciennes, 1839) (Bluestreak cleaner wrasse), *Lutjanus decussatus* (Cuvier, 1828) (Checkered snapper), *Cephalopholis argus* (Schneider, 1801) (Peacock hind/ grouper) and *Zanclus cornutus* (Linnaeus, 1758) (Moorish idol) were recorded from all sites.



Acanthurus lineatus(Linnaeus, 1758)



Upper Left:Monodactylus argenteus (Linnaeus, 1758)

Middle Left:Siganus virgatus (Valenciennes, 1835)

Middle Right:Acanthurustriostegus (Linnaeus, 1758)



Left:Parupeneus macronemus (Lacepède, 1801)

Right:Hemigymnus fasciatus (Bloch, 1792)



Gnathanodon speciosus (Forsskål, 1775)



Acanthurus leucosternon (Bennett, 1833)



Dascyllus trimaculatus (Rüppell, 1829)



Amphiprion clarkii (Bennett, 1830)



Zanclus cornutus (Linnaeus, 1758)

Recommendations

- Awareness programmes and education is required for foreign and local tourists and tourist guides and ensuring harmless snorkeling (diving fins touching corals especially branching corals) and diving (unbalanced bouncing creates damage to corals).
- Specific areas need to be introduced for anchoring boats. Most of diving boats, glass bottom boats, and fishing boats are anchored closer to coral reef beds especially in Hikkaduva and Pigeon Island and creates oil and kerosene pollution. The place needs to be a yard or harbour placed some distance away from the coral reef bed.
- The canoes are anchored using rocks especially on Hikkaduwa coral reef bed for snorkeling. It should be avoided by introducing a suitable harmless method for anchoring.
- Development and management of all fishing activities and construction and maintenance of fisheries harbours.
- Planning and developing the tourist industry according to capacity of the coral reef areas is required.
- Need to strictly control tourist gathering in highly sensitive coral reef areas.
- Formulation and effective implementation of management plans with the aim of protecting relevant coral reefs and reef associated species and such plans need to be prepared based on research findings and recommendations.
- A continuous monitoring programme is needed to report the status of the coral reefs and associated species

Progress : Physical : Financial :

PROJECT NO : 2.3.2

BIOLOGICAL AND FISHERIES ASPECTS OF SELECTED REEF FISHES

Rock fishes are a part of the reef fishery resources, locally known as '*gal malu*'. It is a major part of the demersal catch from the coastal waters. Fishing activities targeting reef fish resources in the West coastal waters take place throughout the year more or less on a continuous basis. Mostly hand line, bottom set long line ('Bata loan') and bottom set gill net ('Elana dal') are used as the fishing gear to catch these rock fish species. Among the rock fish, groupers and snappers are popular marine food fish of highest market value in many parts of the world and few are currently being exported in either live or frozen forms. In addition, there is a novel trend in the export market for some 'Parrot fish' species. Most of the fish product exporters are now seeking to boost up the export of these fishes especially to China and Europe.

Though, there is an increasing trend for export for the rock fish, there is no baseline data such as spawning season and maturity and also no guidelines/ regulations such as allowable sizes for exporting which is a considerable issue for Department of Fisheries and Aquatic Resources (DFAR). Furthermore, as several fishing methods are in use, selectivity of each gear type with respect to the size of fish varies. Also, due to lack of such information, fish stocks are currently in a threatened condition and also there is a risk for harvesting immature fish in a massive scale. Therefore, present study was undertaken with the aim of identifying some important reproductive biological aspects of major rock fish species in selected areas in Sri Lanka.

In order to accomplish the objectives, port sampling survey was carried out in 2017. Negombo, Beruwala and Chilaw were selected for the survey as the worst case scenario with respect to other regions. Selected Fish landing centres at selected locations were visited once a month. Representative fish samples from the catch were collected at each site and brought to the MBRD laboratory. In the laboratory, relevant measurements were taken and specimens were scientifically studied for necessary parameters. A total of 571 specimens were tested at the laboratory in order to accomplish the objectives.

Chilaw fishery district records the highest reef fish species diversity with records of 25 species, 12 species from the family Serranidae and 12 species from family Lutjanidae. Negombo fishery district records the lowest species diversity with records of 18 species, 8 species from the family Serranidae and 9 species from family Lutjanidae. Present study revealed that breeding season for the *Cephalopholis sonnerati, Epinephelus longispinis and Lutjanus fulviflamma* varied December to February, August to October and February to April and from August to October respectively. The number of average eggs per fish for *Cephalopholis sonnerati, Epinephelus longispinis, Epinephelus undulosus and Lutjanus lemniscatus* are 515,000, 22500, 31500 and 7700 respectively.

This research will be continued in 2018 and east coast was also included in order to find out the status of the reef fishery at two regions and to make a comparison between two regions. It is recommended to make necessary decisions to restrict the fishery of respective species in their breeding season as to ensure the sustainability of the stocks in Sri Lankan waters. Considering the findings based on the female specimens, 32.6 cm (TL) is recommended as the minimum allowable size limit for *C. sonnerati* ('Thambuwa') if the prevailing ban needs to be lifted. However, more male

specimens have to be analyzed in order to declare a minimum allowable size limit for male *C. sonnerati* in Sri Lankan waters.





Progress: Physical : Financial :

PROJECT NO : 5
CONSERVATION OF ENDANGERED, THREATENED AND PROTECTED (ETP) MARINE FAUNA IN SRI LANKA AND MUSEUM DEVELOPMENT

PROJECT NO : 5.1.1
GEAR AND SEASONAL EFFECTS ON ENTANGLEMENT OF SEA TURTLES

Of the seven living sea turtle species in the world, five are reported to nest along the coastal belt of Sri Lanka: the green turtle, *Chelonia mydas*, olive ridley, *Lepidochelys olivacea*, hawksbill, *Eretmochelys imbricata*, loggerhead, *Caretta caretta* and leatherback, *Dermochelys coriacea* (Deraniyagala, 1953). The expansion of fishing activities in coastal areas and on the high seas has contributed to the decline of several sea turtle populations. As sea turtles cross the oceans from nesting beaches to foraging grounds and back again, they can become entangled in net associated fishery and line associated fisheries.

The survey was carried out in order to assess the nature of incidents of sea turtle by-catch at fish landing sites in north western and western province by collecting data on marine turtle entanglements in 2017. Five landing sites in west coast and ten landing sites in North West coast were selected for this survey along the Northwest and Western coasts of Sri Lanka between Pukkulama and Beruwala. A total of 720 interviews with fishermen were carried out at the landing sites selected.

Tuna longlines, large mesh gillnets, and bottom set gillnets are mainly responsible for the entanglement of sea turtles. Gillnet fishery has a low sea turtle interaction relative to the longline but relatively higher number of dead turtles are reported in gillnet fishery than longline fishery. Higher numbers are also reported in dead form in Bottom set gillnet (skate nets –Mesh size 12" - 18"). The species of sea turtles recorded in the incidental catch were Olive Ridley (*Lepidochelys olivacea*) 90%, and Green (*Chelonia mydas)* 5%. The highest number of monthly entanglements of sea turtles was observed during the period from January to April in 2017. Present study revealed that the use of fish as bait for tuna longline fishery rather than use of squids is more conducive for

sea turtle survive. Furthermore, use of circular shape long line hooks minimizes the entanglement of sea turtles than use of "j" shape longline hooks.

Recommendations

- Promote to use circle hooks instead of "J" shape hooks in long line fishery.
- Recommend to reduce gear soaking time and increasing number of sets per day in gillnets.
- Awareness programmes need to be conducted for fishermen on marine turtle by-catch issue.
- Conduct training and monitoring programmes about best practices for retrieving and de-hooking turtle capture in tuna longlines.
- Promote use of fish as a bait instead of squids.

Progress : Physical : 90% Financial :

PROJECT NO : 5.1.2

STUDY THE SPATIAL AND TEMPORAL DISTRIBUTION AND ABUNDANCE OF WHALES FOR CONSERVATION AND MANAGEMENT

Coastal waters of Sri Lanka have been identified as very rich cetacean grounds with many species. Cetacean populations off the southern coast are facing multiple threats such as ship strikes, disturbances due to whale watching and maritime transportation, fisheries etc. Management and conservation of endangered whales and dolphins depend on our ability to predict their distribution, abundance and migration pattern.

Marine mammal distribution and abundance data were collected from the commercial whale watching boat (Raja and the whale). This vessel operates every day for whale watching from Mirissa fishery harbour. During the survey period, 11 species of cetaceans (blue whale - *Balaenoptera musculus*, bryde's whale – *Balaenoptera brydei*, sei whale- *Balaenoptera borealis*, fin whale- *Balaenoptera physalus*, sperm whale – *Physeter macrocephalus*, spinner dolphin-*Stenella longirostris*, bottlenose dolphin-*Tursiops truncatus*, shortfinned pilot whale- *Globicephala macrorhyncus*, risso's dolphin- *Garampus griseus*, stripped dolphin-*Stenella coeruleoalba*, falls killer whale *Pseudoorca cressidens*, killer whale *Orcinnus orca*) were recorded from the south coast of Sri Lanka. Among the larger cetaceans, Balaenopteridae (blue whales) were recorded every season of the year with a higher abundance. Highest average daily blue whale sighting rate of 5.25 ± 4.02 (min 1 max 25) whales /day was recorded during the Northeast monsoon (Nov-Feb) period. During the Southwest monsoon season (May to Aug) and Second inter monsoon period (Sep–Oct) it was recorded as 4.28 ±3.76 (min. 0, max 12) and 2.0±3.76 (min 0, max 9) respectively. Within the First inter monsoon (March to April), blue whale sighting rate was 2.0 ± 2.0 (min 0, max 9). Because of the blue whales dependency on single prey item (Euphaussid krills) their abundance and migration pattern tightly coupled with the oceanic processes influence the krill production. Year round high abundance of blue whales in south coastal area revealed that high krill productivity of the area support to fulfil the energy requirement of larger cetaceans. Further, results revealed that part of blue whale population may be residence around Sri Lanka and migration pattern of the rest of the whales not yet clearly understood. However, it is believed that they might be migrating towards the more productive Arabian sea area or Antarctic area not toward the low productive bay of Bengal area. Blue whale sighting rate in the southwest coastal region is higher during the northeast monsoon but strandings are higher during the southwest monsoon. Since the south coast is faced to the southwest monsoonal winds whale carcasses float to the southwest coastal region than the

other coasts. Further, highest distribution and abundance of blue whales on the dense shipping area of the south coast (Dondra head) adversely impact on their feeding, resting, echolocation, hearing, breeding etc. In addition to that, highest number of blue whales stranded (2 of 2) on the southwest coast emphasizes the risk of accidents or natural deaths are comparatively higher within the southwest coastal region of the country.

Spinner dolphins are the most common dolphin species found in the area throughout the year with high abundance (mean 2837 individuals per month). Bryde's and sperm whales were found throughout the year, but number of sperm whales was higher during the period of March to April. On average all the species were recorded during the months of February, March, April and November.

Dolphin, whale and dugong stranding data and samples collected throughout the coast of Sri Lanka with the support of field data collectors of NARA, Department of Wildlife Conservation and some other agencies were used for genetic identification.

Progress : Physical : % Financial :

PROJECT NO : 5.1.3

MARINE MUSEUM UPGRADE AND SKELETON PREPARATION

A number of preserved marine specimens including endangered, threatened and protected (ETP) species are displayed in the MBRD marine museum. The main purpose of the preservation of marine specimens is to display them for educational purposes for school children, university students and other interested parties. Further, marine museum convey the message to the public about the importance of the marine biodiversity and neediness of biodiversity conservation for future generation. A carcass of a striped dolphin, *Stenella coeruleoalba* (Meyen, 1833) found from crow island, Mattakkuliya beach has been temporally preserved in a tank with formalin (wet preservation) until a suitable tempered glass tank is prepared for displaying it at MBRD museum. The specimens in MBRD museum were refilled with formalin and new specimens collected from the field were wet preserved using formalin. All other dry preserved specimens (whale skeleton, Dugon's preserved dry skin and skeleton, dolphin skulls, dolphin skeletons, turtle's carapaces, shark's jaws and whale's baleen plates) were painted using appropriate paints and clear varnish. A coral display board and a diver's dummy were prepared to display for the public. Dead coral specimens (calcified exoskeleton) were collected from the field (Jaffna, Mannar, Silavathurei, Vankalei and Kalpitiya) and prepared for display after bleached processing.

PROJECT NO : .1.2

STOCK ASSESSMENT OF FISHERY RESOURCES (INDEPENDENT SURVEY) IN COLLABORATION WITH NORWAY

Sri Lanka and Norway has a long-standing cooperation within the fisheries sector dating back to the beginning of 1970's. In recent years, a fact-finding team prepared the report "Possible Areas for Cooperation within the Fisheries and Aquaculture Sectors between Sri Lanka and Norway" in 2012. Based on this, a project was formulated in cooperation between National Aquatic Research and Development Agency (NARA), Sri Lanka and Centre for Development Cooperation in Fisheries (CDCF) at Institute of Marine Research, Norway with focus on two areas; 1) Fish quality, food safety and

post-harvest aspects and 2) Oceanographic and hydro graphic surveys using a newly acquired research vessel in Sri Lanka.

In January 2016, a new request was received from Sri Lanka to continue the cooperation and a new fact finding mission was organized by the Norwegian Agency for Development Cooperation (Norad). This mission defined new priorities for the fisheries cooperation and decided to go forward with two project components within this project:

- Work package 01 - Assistance to upgrade existing NARA's port sampling programmes on fisheries data collection and data processing
- Work package 02 - Fish stock assessment including resource surveys with RV. Dr. Fridtjof Nansen and provide assistance to NARA on assessment of fisheries resources using their own R/V Samuddrika.

The goal of the two work packages are: improved management and conservation of the marine resources in Sri Lanka to provide NARA and the fisheries management at DFAR with the tools to determine the long term maximum sustainable yield from the fishery for the benefit of the Sri Lankan community, the local fishermen, fishing industry and consumers.

Project activities in relation to WP1 and WP2 were started after the project inception workshop held in June 2016.

Activities carried out/ in progress under the Work Package 1:

Methodology

WP1 consists of a series of activities

1.1 Review previous report and publications on data collection systems

1.2 Conduct a baseline survey

1.3 Develop a sampling strategy

1.4 Prepare guide lines, data collection forms etc.

1.5 Field testing of data collection forms

1.6 Conduct training at National and field levels

1.7 Establish inter agency mechanism between NARA and DFAR

1.8 Create database design

1.9 Develop database

1.10 Training in analyses of fisheries statistics

1.11 Conduct pilot level data collection

By conducting these activities, project objectives will be accomplished. Under this project, several parties (NARA, Department of Fisheries and Aquatic Resources (DFAR) and Statistics Unit of Ministry of Fisheries and Aquatic Resources Development (MFARD)) work together. All related documents/ produced reports under this work package have already been uploaded into a Google drive.

Progress in work package 1

1.1 Review previous report and publications on data collection systems

Reviewing previous work was completed and a report was prepared and uploaded to the Google drive

1.2 Conduct a baseline survey

Baseline survey was conducted by NARA with the support of DFAR and MFARD. All the landing site data around the country was collected. Draft report is available in Google drive During the survey nearly 900 landing sites (including lagoon fishery) were recorded and different fishing practices were observed.

1.3 Develop a sampling strategy

With the help of Norwegian experts sampling strategy preparation is now in progress

1.4 Prepare guide lines, data collection forms etc.

New data collection sheet was designed for all fishery types and data collection sheet is almost finalized.

Data collection manual is also being prepared.

1.5 Field testing of data collection forms

Draft data sheet has been distributed among NARA Field Research Assistants (FRAs) for field testing to confirm whether data sheet is working for all fishery types.

1.6 Conduct training at National and field levels

A workshop was held at Clarion Hub Negombo from 21st to 22nd August 2017 to introduce and discuss the project to NARA FRAs and DFAR Fisheries Inspectors

1.7 Establish inter agency mechanism between NARA and DFAR

This was established at initiation of the project. NARA and DFAR work together to accomplish all the goals included in this project. Weekly or bi weekly meeting were organized to discuss the project progress.

Activity 1.8 to 1.11 will be addressed after completion of the sampling strategy.

Upgrade R/V Samuddrika for fish stock and ecosystem assessment surveys

R/V Samuddrika is a multidisciplinary research vessel commissioned in 2012 to conduct hydrographic, oceanography and fisheries research. The 189-ton vessel is 25 meters in length and 6.5 meters in width with the endurance of 5 days could accommodate 16 persons, including 7 scientific staff.

The vessel undertakes routine hydrographic surveys for nautical charting and limited oceanographic surveys but could not commence fisheries surveys. The "Sri Lanka – Norway Bilateral project on the Sri Lankan Fisheries and Aquaculture Sectors" in 2013-14, under the "Project component 2- Capacity building in research vessel deployment for oceanographic surveys and fish stock assessment", had identified the requirements and modification to transform the vessel into a fully-fledged multidisciplinary research vessel, as originally intended.

NARA made various attempts to use the vessel efficiently and effectively for survey purposes, including setting up of vessel management team, comprising Deputy Director General, Director/M&E, Chief hydrographer and Senior Scientists. The vessel management committee had initiated various attempts but could not succeed as it did not have sufficient "know-how" on vessel operation and maintenance.

Crew of the vessel expressed that the existing vessel administrative system is cumbersome and time consuming and requires a "rapid response system" to keep the vessel ready for surveys. Similarly, the scientist, the intended users are of the opinion that mobilizing the vessel for survey is exhausting and needed a system set up to make available the vessel for survey without hassle.

The working Group had identified the following activities to transform R/V Samuddrika into a fully-fledged multidisciplinary survey and research vessel and efficient and effective use of it. The objectives of this component of the project are to constitute a survey committee, to be the national platform available to conduct coastal and offshore research in Sri Lanka and for the smooth operation of RV for surveys.

During the year 2017 most of the objectives were fulfilled. The vessel management committee and the survey committee have been established to ensure efficient and smooth management of R/V Samuddrika. In addition, the modification plan for the vessel has been finalized according to the future research needs. Furthermore, considerable amount of the modifications for R/V Samuddrika has been completed during the year. Also NARA's Engineer and ship's instrumental in charge were trained in Norway with the aim of smooth running of the vessel for marine surveys.

Competence building within fisheries independent survey

The only survey assessment of the marine stocks off Sri Lanka was done by the Nansen program during 1978-1980. Three surveys were carried out with R/V "Dr. Fridtjof Nansen" in August - September 1978, April - June 1979 and Jan-Feb 1980, respectively. The estimates from those surveys are still used as a basis for evaluation of commercially harvested stocks. Since 1980 there have not been any scientifically designed systematic fish abundance surveys in Sri Lankan marine waters except the CENARA survey conducted during 2008/2010 by NARA targeting some export oriented

fishery resources in selected areas. The government has a future plan to increase the fish production in a sustainable manner. Prior to implementing this ambitious programme of the government, an assessment of the present status of economically important fish stocks is needed. it's important to identify the sustainability of the fish stocks under the current state sponsored development strategies. To estimate maximum sustainable yields of fish stocks, and biomass, it is very important under the scenario of unreliable fishery dependent statistics. Scientifically planned fishery independent stock assessments have to be carried out with respect to small pelagic, large pelagic and demersal fish stocks. If surveys were carried out as suggested, the project can utilise this opportunity for training of personnel at all levels, as well as giving an update of the assessments from the late 1970s.

The main objectives of the work package were capacity building of NARA staff to conduct systemic fish abundance estimation, to recommend the management strategies and policies for the fisheries sector of Sri Lanka to investigate stocks of unexploited/ underutilized demersal fishery resources on the continental shelf and slope.

A series of training courses were held to build competence of NARA and DFAR staff by Norwegian Scientists. Introduction to fisheries acoustics, survey designing and alternative survey methods were the prominent training courses. In additions to the local trainings, two NARA scientists were trained in Norway for marine surveys in a research vessel Under this project, a video sled was developed to estimate the abundance of benthos using R/V Samuddrika. This could be an efficient and cost-effective method and good alternative method for surveys using commercial divers. Accordingly, few successful trails with the video sled were carried out for the first time in Sri Lanka and NARA's scientists were trained to operate this instrument and data processing.

PROJECT NO : 5.4

POST OPERATIONAL IMPACTS OF NOROCHCHOLEI COAL POWER PLANT ON BIOLOGICAL RESOURCES AND MARINE ENVIRONMENT

Lakvijaya coal-fired power station was established in 2006 to fulfill the national power need. Operational impacts of coal fired power plant are highly discussed among the stakeholders as this is the first experience in power generation using coal in Sri Lanka. This particular aspect of the study was conducted to identify the post operational impacts to fisheries and other biological resources under the main project "Identification of the Environmental Impacts of the Cooling Water System of Norochcholai Coal Power Plant", conducted by Environment Studies Division of NARA for 2017.

Activities undertaken

- Studying the variation in Catch Per Unit Effort (CPUE) with respect to different fishing gears in adjacent fish landing sites
- Density distribution of Ichthiyoplankton in adjacent coastal waters.
- Underwater visual survey
- Socio economic survey

Findings

- CPUE values in bottom set gillnets in Thalawila landing site largely varies between 6.3- 50 kg/boat/day.
- Average density of fish eggs and larvae varied between 2-12 individuals/m^3
- Nearly $348x10^3$ numbers of fish larvae /eggs come through the inlets have died per hour due to high temperature.

Recommendations

- Volume of aquatic organisms sucked into the cooling water system needs to be minimized
- Installation of Fish Enhancing Devices (FED) under the guidance of NARA is recommended.
- Monitoring of fish catch in adjacent fish landing sites and monitoring of impact on coral reef ecosystems adjacent to the power plant (Thalawila, Kandakuliya) need to be continued.
- Falling of coal needs to be be prevented while coal loading and unloading by using a curtain hung on ship and the barges.





PROJECT NO : 1.17

CONSERVATION AND MANAGEMENT OF AQUATIC ENVIRONMENT: DEVELOPMENT OF ENVIRONMENTAL PROFILE TO LAGOONS IN SRI LANKA

Scope of the project was to study ecological, biological, fisheries and socio economic aspects to formulate effective lagoon management plans for selected lagoon and sustainable utilization of the lagoon environment with a view of introducing livelihood development activities, increasing productivity while conserving the lagoons for future. This project was a collaborative study with other research divisions of NARA. The research staff of MBRD was involved in studying some biological and fisheries aspects at five lagoons namely; Puttalam lagoon, Negombo lagoon, Kokilai lagoon, Panama lagoon and Rekawa lagoons for year 2017. The data were collected in relation to the qualitative description and classification of the biodiversity (species and ecosystems) including information on ETP species, fish & other animals and identified the economically important fish species and invertebrate species. Furthermore, data on existing fishing operations including the types of fishing gear used were collected.

Kokilai lagoon

35 species representing 26 families were recorded during the survey. Most of them are food fish varieties with higher consumer demand. Some fish species recorded are marine and entering to the brackish water for breeding and spend some parts of their lifecycles inside the lagoon. Very small size individuals were observed in the catches and small mesh gill nets, bottom set gillnets and Puttu del (*Siganus javus*) operating inside the lagoon are mostly responsible for catching undersize fish. Very small size of groupers (*Epinephelus* sp.) were commonly observed in the catches of bottom set gill nets.

Negombo lagoon

The number of finfish species recorded during the study period at Negombo lagoon was 67; representing 36 families. Among those, the dominant species include *Mugil cephalus* (flathead mullet), *Arius* spp, *Chanos chanos* (milkfish), *Siganus* (orawa) spp., *Lates calcarifer* (modha), *Etroplus* spp (korali) and *Oreochromis* spp (thilapiya). It is recommended to implement a regular fish/ non fin fish catch monitoring programme, also a study to identify the causes for the deterioration of water quality and identification of eco-friendly / harmful fishing methods carried out in the lagoon.

Panama lagoon

During the study, a total number of 54 species belonging to 30 families were recorded from the fisheries catch. The Catch per Unit Effort (CPUE) was calculated as kg/person/day. The average CPUE was 4.12 kg/person/day. It is recommended to strengthen the existing co-management system as to ensure the sustainable utilization of the lagoon fishery resources, deepen the lagoon in an appropriate manner with the technical assistance of the NHO division of NARA in order to rehabilitate the lagoon ecosystem. Enhancing the existing fishery by introducing *Oreochromis niloticus* to the lagoon ecosystem could be successful. But augment of this fish stock should be done with great care as not to violate the ecological balance of the lagoon ecosystem and also it is recommended to assess the prevailing mangrove cover (species composition, density, distribution...etc.) and take necessary actions to protect the mangrove cover. Moreover, it is recommended to make necessary actions for the protection of turtles as it is a threatened species.

Rekawa lagoon

A total of 29 species belonging to 19 families were recorded among the catches. Among the important finfish species *Nematolus nausa, Arius sp.* and *Etroplus suratensis* dominated the catches and *P.indicus* and *Scylla serrata* (mud crab) were among valuable crustacean species caught in Rekawa lagoon. Shad (*Nematalosa nausa*) length frequency data showed that the total length of fish caught in this lagoon varies from 10.0cm to 25.0cm. The present study shows that gillnets operated with canoes catch an average rate of 3.5 kg per operation. Fishermen claimed that there was a good fishery for shrimps (*P.indicus*) in rekawa lagoon a few decades ago. However, due to the formation of a sandbar at the sea mouth, and the debris of Kapuhenwala bridge makes the recruitment of prawns to the lagoon more difficult. A feasibility study needs to be carried out to access the costs and other implications of a periodic opening of sea mouth at Kapuhenwala for the exchange of water between the lagoon and the sea.



net operated in the Kokilai lagoon



Sail oru operated in the Negombo lagoon

External funded projects/ consultancy work carried out by MBRD

PROJECT NO : 1
CENARA PHASE II- IMPLEMENTATION OF FISHERIES CO-MANAGEMENT PLANS

The fishing industry in Sri Lanka plays an important role in its economy. Some export oriented fish and shell fish species are declining heavily at present due to high exploitation rate followed by the foreign demand. Among those, lobster, sea cucumber, chank, marine ornamental fish and shrimp play a major role in the Sri Lankan fisheries export market due to the high value being fetched for those commodities. At present the resources have been heavily exploited due to the high demand for all those varieties in the export market. In addition to that, these resources are exploited by the small scale fishermen in specific areas based on the resource availability. Rules and regulations introduced by the government of Sri Lanka for management and conservation of these resources are poorly practiced.

Considering the economic and social values of the selected fisheries, stock assessment surveys were conducted with the aim of establishing proper management regimes for sustainable utilization of the resources. During 2008 to 2009, resource assessments and declaration of management areas had been partially completed under the Phase I of the CENARA Project with the financial support and technical assistance received from FAO, IFARD and CIDA.

Implementation of Fisheries Co management plans under CENARA phase II was started in November, 2016 with the financial support of CIDA through FAO. The project was implemented by NARA in 2016/ 2017 in collaboration with Department of Fisheries and Aquatic Resources. Implementation of co-management mechanism was adapted with the recommendations of the recourse surveys conducted in the South and North West coasts of the country.

Pilot survey

Pilot survey was conducted in each fisheries management area to identify the landing sites, different fisheries, number of fishers in each landing site, craft types and number and fisheries season etc.

Socioeconomic survey

Socioeconomic survey was conducted in Puttlum & Mannar (Fisheries management area 1), Galle & Matara, (Fisheries management area 2) Hambantota (Fisheries management area 3), Ampara and

Baticaloa (Fisheries management area 4) to update the socioeconomic status of the fisheries community in different districts and different fisheries.

Resource surveys

Resource surveys were conducted in four districts (Hambantota, Galle and Matara together, Puttlum and Mannar) fisheries management areas to update the resource status based on the fisheries dependent data. Resource survey reports with recommendations were prepared for the utilization for preparing the management plans.

Fisheries management committees and district fisheries management committees

Six district meetings were conducted for all selected districts to identify the gaps. The management committees established under the CENARA phase I was re-organized for all districts other than the Mannar District. Since management committees had not been established in Mannar district under the CENARA phase I, five management committees were newly established in Mannar district. Within the period, only two district fisheries management committees were completed for Hambanthota and Galle & Matara districts together

Declaration of Fisheries management areas

Declaration of the East coast fisheries management area has been completed and gazetted.

Declaration of the Northwest fisheries management area is in progress.

Lobster stock enhancement programme

Two awareness programmes were conducted in Polhena and Tangalle fisheries management committees regarding in-situ conservation of berried lobsters. Further, new spiny lobster rearing pen was established and lobsters were stocked in the sea at Polhena with the participation of the members of Polhena fisheries management committee and DFAR.





Pen for in-situ conservation of berried lobsters in Polhena

Introduction of Fisheries Log books for data collection

Three types of fisheries log books were introduced in Sinhala and Tamil languages to collect the fisheries dependent data through the fishermen.

PROJECT NO : 2
GEF SEA GRASS AND DUGONG CONSERVATION PROJECT

The GEF Dugong and Seagrass Conservation Project focuses on the northwest of Sri Lanka, namely the Gulf of Mannar and Palk Bay. The area includes the largest of Sri Lanka's Marine Protected Areas – the Bar Reef MPA, west of the Kalpitiya peninsula in the vicinity of Puttalam lagoon – which covers approximately 310 km^2. Project site selection was based on results of the Dugong MoU survey carried out in 2013 by the Convention on the Conservation of Migratory Species of Wild Animals (CMS), as well as long-term studies and field surveys implemented by the project partners. Under the main project, NARA works on the two major areas, impact of the fishing operations on the seagrass and dugong habitats. Mainly various types of gillnets (Crab net (mesh size – 4-5.5"), Skates and rays targeting bottom set gillnet (mesh size–16-18"), Seer fish targeting gillnet (mesh size – 6")), Fyke nets and trawl nets are operated in the seagrass associated areas and dugong habitats. Among the fishing gears operated on seagrass beds and associated areas, bottom set gillnet, bottom trawling and installation of Fyke nets on seagrass beds as a passive gear are negatively affected to seagrass ecosystem. Bottom set gillnets of mesh size–16-18" shows the highest risk on the dugong within the study area.

PROJECT NO : 3
PORT CITY DEVELOPMENT PROJECT: MONITORING FOR IMPACT CONFIRMATION

In accordance with the development permit for the Port City issued by Coast Conservation and Coastal Resource Management Department, The Ministry of Megapolis and Western Development needs to confirm effective implementation of mitigation measures on the biological environment in the sand dredging areas. Currently studies on species diversity and density of migratory fish species & spawning biomass of squids & shrimps, changes of macro zoo benthos, status of the reefs called Diyambala, Onagala and Kalapugala situated near to the dredging sites are being monitored by MBRD.

The monitoring of species diversity and density of mature/running fish, spawning biomass of shrimp and squid at the sand exploration site – offshore Negombo (Site 2 of sand dredging) is being carried out during 2017 in quarterly basis followed by a baseline study. Both fisheries dependent and independent data is being used. It is observed that of fish species which were reported at the baseline survey could not be observed during each monitoring. On the other hand, few fish species have been added to the baseline species list. Availability of certain fish species can be greatly influenced by the seasonality or sometimes they show various type of migratory behavior from habitat to habitat. The monitoring of macro zoo benthos are being carried out within the dredging site using grab sampling method where it has been noted some changes in the densities of certain species such as crustaceans and molluscs and also changes in the composition of certain species such as echinodermates and polychaetes. This study is being conducted once per year.

The monitoring of species diversity and density of reef fish, coral, marine invertebrates in the three selected reefs (Onagala, Diyambagala and Kalapugala) was conducted in March 2017 followed by the baseline survey. Under water visual survey method is being used. It is observed that some changes in

fish and invertebrates species diversity and density during the baseline phase and monitoring phase. Coral species diversity was relatively equal in the both phases.

PROJECT NO : 4

PRDS PROJECT: CARRY OUT A MARINE ENVIRONMENTAL BASELINE SURVEY WITHIN THE EXCLUSIVE ECONOMIC ZONE (EEZ) OF SRI LANKA

A consultancy was awarded to NARA by Petroleum Resources Development Secretariat (PRDS) to carry out a marine environmental baseline survey within the Exclusive Economic Zone (EEZ) of Sri Lanka with a view to prepare for mandatory Environmental Impact Assessments (EIAs) for future hydrocarbon explorations and exploitation. These data would pave the base for any future comparisons and accelerate the EIA process. Accordingly, the aim of the assignment was to collect marine environmental baseline data within EEZ of Sri Lanka which provides a vast array of data to facilitate mandatory environmental impact assessments to carryout future hydrocarbon explorations and exploitation. Accordingly, MBRD successfully conducted the marine environmental baseline survey with regard to sensitive habitats (coral reefs), marine resource survey and marine mammals.

PROJECT NO : 5

FISH REPRODUCTIVE BIOLOGY STUDY TO IDENTIFY FISH BREEDING SEASON OF SPECIFIC FISH TARGET BY SMALL PURSE SEINERS OPERATED IN MANNAR, SRI LANKA

Market Development Facility (MDF) is a company funded by the Australian Government with the goal to create economic growth and hence employment and income-earning opportunities for the poor and under privileged by making selected sectors of the economy more competitive and stimulating business innovation. A Consultancy Contract sets out the terms and conditions under which the Market Development Facility works with NARA to achieve the goals and objectives stated in another Agreement signed between MDF and the CM Fish Canning (Pvt) Ltd (Coolman). The Cool Man Fish Canning (Pvt) Ltd in the last few years has taken the strategic decision to invest in a fish canning and fish meal processing facility at the Pesalei Fisheries Zone. The reason for choosing the site was an obvious one: cheap and abundant source of fish, where there are days when the catch in the region is averaging 100,000kg per day alone. Especially in Thalai Mannar, in the “Mannar Bay” huge quantities of Kelee shad (Karattaya), Indian oil sardine (Yaksalaya) are caught during the season. Favourable marine tropical conditions stimulate breeding, which leads to a high amount of fish being available. Since the area is slightly remote and there are no provisions to process excess catch, most of the excess catch are converted to dry fish or dumped back into the ocean. On the other hand, fishermen in the area don’t have sustainable fishing activities where Coolman wants to find out the peak fish breeding seasons of Kelee shad and Indian oil sardine. Then Coolman will initiate short term non-purchasing periods based on the study to allow fish to breed and grow their population continuously without affecting the supply of raw materials for fish cannery and the fish meal production facilities.

The preliminary survey with regard to the study on fish reproductive biology was conducted by MBRD in December, 2016 in Mannar Fisheries District with the aim of selecting suitable fish landing sites and designing the survey for fisheries data collection and biological sampling. In each month of 2017, freshly caught fish samples from purse seine fishing operations (Kelee shad (*Hilsakelee*); Indian

oil sardine (*Sardinella longiceps*); White sardinella (*Sardinella albella*)) obtained at the two sampling sites were brought to the MBRD laboratory with ice and preserved at the laboratory in a deep freezer for biological analysis. Each individual fish was examined and measured for total length (cm), fork length (cm), body weight (g), somatic weight (g), gonad weight (g) sex and maturity stages. After obtaining the length and weight measurements of the fish, each individual fish were dissected to identify the sex and maturity stages. The gonads of the fish were removed and examined. Accordingly, maturity stages were classified under five stages.

Other activities undertaken by MBRD

1. Examined and provided reports on fish samples sent by various high courts for blast fishing.
2. Examined and provided a report on identification of gastropod shell samples sent by the magistrate courts.
3. Examined and provided reports on identification of shark fin samples sent by the fish exporters.
4. Lectures were conducted on the importance of biodiversity and coral reefs for coast guard, Sri Lanka.
5. External Supervision of B.Sc final year research project: On a request made by the Head Department of Animal Science, Uva Wellassa University, a Special degree undergraduate student (Ms. A.G.D.M. Perera) was supervised for her 4 month final year research project on Marine Biotechnology.
6. Marine mammal flesh samples submitted by the Department of National Zoological Gardens (Court case no. B/245/17 of the Mannar Magistrate Court) were identified by DNA sequencing as belonging to dugong samples.
7. A flesh sample submitted by the Colombo Magistrate court (court case no. 80495/05/17 was identified by DNA sequencing as belonging to a Big Eye Thresher Shark.
8. The fish species contained in a canned fish tin submitted by the Consumer Authority of Sri Lanka was identified by DNA sequencing as belonging to the species *Decapterus russelli* (Linna).
9. Served as a member of the Technical Evaluation Committee for 2017 for the purchasing of chemicals and consumables of NARA.

Publications

Abstracts

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11. H.B.U.G.M. Wimalasiri, S.U.P. Jinadasa, D.C.T. Dissanayake., (2018), Assesment of bioluminescence in off south coast and Puttalam lagoon of Sri Lanka. *Second International Conference on Oceanography of Bay of Bengal, with emphasis on Monsoon Intra-Seasonal Oscillations*, 10-11th January, Cinnomon Grand hotel, Colombo, Sri Lanka.

12. H.B.U.G.M. Wimalasiri, S.U.P. Jinadasa, D.C.T. Dissanayake., (2017), Bioluminescence in Puttalam Lagoon of Sri Lanka, *NARA scientific sessions,* 27th July National Aquatic resources Research and Development Agency, Mattakuliya.

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Workshops/meetings attended:

1. Workshop on Bioinformatics and Systems Biology. 15th - 17th June 2017. SLAAS and University of Sri Jayawardenapura.

2. An interactive workshop on 'Converting a draft manuscript to Ready to Publish manuscript'. 1st and 4th August 2017. NSF, Colombo 7.

3. *ISBIS-Co-sponsored Workshop on Time Series Analysis in Data Science and workshop on Scientific Writing Conducted from 20th to 22nd of December, 2017 at PGIS*

4. *Workshop in Biostatistics using R 16th December 2017 at University of Kelaniya organized by SLAFAR and Department of Zoology and Environmental Management*

5. International workshop on tropical-subtropical weather, climate and ocean organized by South China sea institute of Oceanology from 18th to 20th November 2017 at Ramada Pearl hotel, Guangzhou, China.

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5. Rathnasuriya, M.I.G., Weerasekera, S.J.W.W.M.M.P., Bandaranayake K.H.K. & Haputhantri S.S.K. Neritic Tuna Catch, Species composition and monthly average landings in Sri Lankan Tuna Gillnet Fishery operate within EEZ, Paper presented at the Indian Ocean Tuna Commission (IOTC) 7th Session of the IOTC Working Party on Neritic Tunas, 10-13 July 2017, Male, Maldives.

6. R.A.M. Jayathilaka , H.A.C.C.Perera and S.S.K.Haputhanthri, (2017). Marine turtles of Sri Lanka; Status, Issues, Threats and Conservation Strategies. IOTC-2017-WPEB13-36 Rev_1. San Sebastian, Spain.

7. Haputhantri S, Relationship between skipjack tuna CPUE and fishing operation related parameters: A case study for the gillnet fishery of Sri Lanka (2017), Paper presented at the Indian Ocean Tuna Commission (IOTC) 15th Working Party Meeting on Tropical Tuna,17–22, October 2017 Seychelles.

Representing MBRD Scientists at National Committees/ National Services

1. National Expert Committee Member on Biological Diversity (NECBD) coordinated through the Biodiversity Secretariat, Ministry of Mahaweli Development and Environment. (2016/2017) - R.P.P.K. Jayasinghe.

2. Focal Point for Work Package 2 (Technical assistance and competence building in Fisheries Research) of "Sri Lanka – Norway Bilateral project" to improve the management of the fish resources of Sri Lanka (2017/2018) - R.P.P.K. Jayasinghe.

3. Committee Member of Fisheries Management Coordinating Committee of North West coast (Puttalam District) fisheries management area (2017/2018) - R.P.P.K. Jayasinghe

4. Committee Member of the National Committee on Agricultural Biotechnology under the CARP (since May 2013) – D.R. Herath

5. Committee Member of the Working Committee on Biotechnology of the National Science Foundation (NSF) (since June 2016) – D.R. Herath

Consultancy Services

1. Upon the request of Petroleum Resources Development Secretariat (PRDS) of Sri Lanka, a desktop study on "Gathering of available data on baseline environmental conditions and gap analysis" is currently being carried out by NARA. MBRD has contributed to the study providing information on biological living resources and coral reefs.

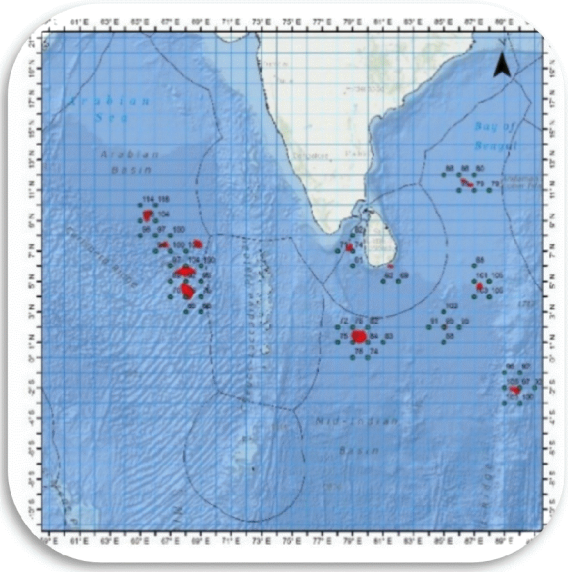
2. Monitoring the impact on biological resources due to sea sand extraction at "Site 2" in the west coast of Sri Lanka for Colombo Port City Development.

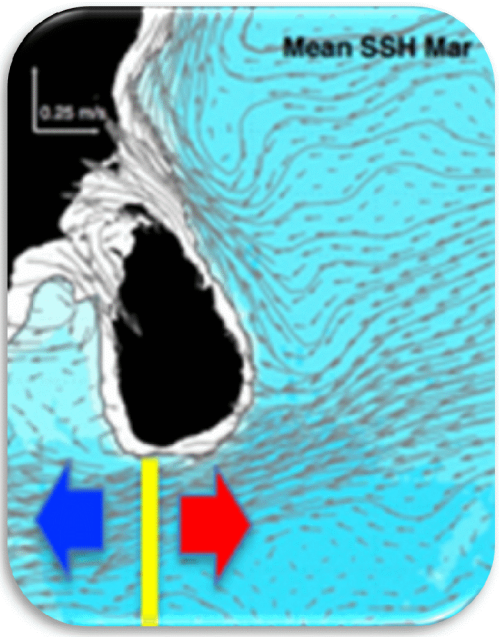
3. Geological Survey and Mines Bureau (GSMB) of Sri Lanka has requested NARA/MBRD to provide recommendations for sustainable harvesting amount of dead sea shells at Thambalagamuwa Bay in Trincomalee.

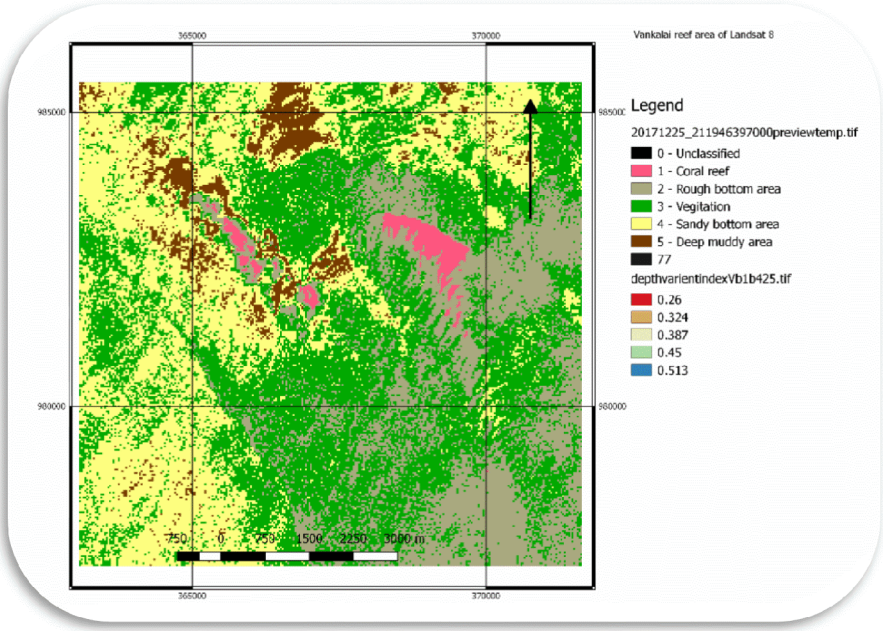
International Collaborations

Sri Lanka – Norway Bilateral project to improve the management of the fish resources of Sri Lanka with the technical support of Norway.

National Institute of Oceanography and Marine Sciences







5.6 NATIONAL INSTITUTE OF OCEANOGRAPHY AND MARINE SCIENCES

Head of the Division: Dr. K. Arulananthan

Introduction

Oceanography Division is responsible for planning and conducting coastal and offshore oceanographic studies around Sri Lanka. In this regard oceanographic and marine geological scientists conduct research in the fields of physical, chemical, biological oceanography. The Division has been conducting research on coastal and deep ocean research having long term archival of oceanographic datasets such as tides, currents and waves. The division provides its scientific and technological services to a wider range of applications such as coastal constructions, living and non-living resource exploitation, and energy harnessing including environmental impact assessments (EIA).

Progress of Research Projects

Oceanography Division has conducted six major projects and several consultancy services during the year 2017. Following are the major projects conducted by the division during 2017.

Table 1: Projects Carried-out by Oceanography division in 2017

Project No	Projects	Allocation	Responsible Officers
1.5.1	Tuna fishing ground forecasting and fisheries information services	2 M	Dr. J.K Rajapaksha Mr. S. Gunasekara
1.5.2	Operation ocean observation center and sea level monitoring station	2 M	Dr. K. Arulananthan
1.6.1	Spatio-temporal variability of Hydrography at southwestern and eastern coasts of Sri Lanka	5 M	Mr. S.U.P Jinadasa, Mr. Akila Harishchandra Dr. H.B. Jayasiri
1.6.2	Assessment of phytoplankton with special reference to toxic dinoflagellates, off west coast of Sri Lanka	0.75 M	H.B. Jayasiri
1.6.3	Quantitative analysis of micro-plastic debris in selected sites of Western and Southern coastal stretch	0.5 M	Mrs. Dileka Samaranayake Dr. H.B Jayasiri
4.2.1	Exploration of near shore placer mineral deposits around Sri Lanka	0.827 M	Project is discontinue due to the unavailability of assigned officer
4.2.2	Integrated Effort on habitat mapping around Sri Lanka (Vankalei reef)	1.10 M	Mr. S.U.P Jinadasa Mr. Akila Harishchandra Mr. S.Gunasekara
5.8	Establishment of Center for National Oceanographic Database for Sri Lanka	1 M	Dr. K. Arulananthan

PROJECT NO : 1.5.1

TUNA FISHING GROUND FORECASTING AND FISHERIES INFORMATION SERVICES

Responsible Officers : Dr. Jagath Rajapaksha
Mr. S. S. Gunasekara

Introduction

Total marine fish production of Sri Lanka in 2014 amounted to 459,300 tons while offshore and high seas fishery contributed 180,450 tons, 39.2% (MFAR, 2015). Operated fishing boats have been 4,447 and 1500 boats have been equipped with VMS. Sri Lankan offshore high seas fishery sector operated with by longline, gillnets and ring net or combination of them. Longline fleets mainly targeting large pelagic species such as yellowfin tuna (*Thunnus albacares*), big eye tuna (*Thunnus obsesus*). Major target of the gillnet operators is skipjack tuna (*Katsuwonus pelamis*) and ring net targets for Indian scad (*Decapterus russelli*).

Development of fishing ground forecasting system for offshore fishery in Sri Lanka was started in 2007 and implemented in 2008 on experimental basis. Experimental forecasts were released in weekly basis to selected fishing fleets and the validation results of the forecast have shown encouraging results. Hence, the forecast dissemination was expanded to all major fishery harbors via fax, email and radio communication. Since November 2015, fishing ground forecast provide twice a week. Forecasting area has been increased to cover almost area where Sri Lankan fishing vessels fishing. During 2016, fuzzy logic base forecasting model was developed and accuracy assessments with VMS verified fisheries logbooks shown 67% accuracy of improved forecasts.

However, there were several challenges have been found to be overcome in order to enhance the fishing efficiency ~~to~~ that will ensure the high catch rates. Migratory behavior of tuna species is one of the major challenges, it can be horizontal as well as vertical. Vertical migration is a slow process with the thermocline variability influenced by mixing which depends on seasonal monsoons winds. However, horizontal migration is more complex and related to the biological life stages.

Usages of near real-time satellite information are therefore important and providing information on swimming depth of yellowfin tuna can make a considerable impact on the fishing efficiency. As the mixed layer of the Indian Ocean is heavily influenced by its monsoonal wind reversals, the tuna vertical migration due to thermocline variability is significant. As a result, depth of deployment of tuna long line is uncertain and experienced low catch rates. The existing fishing ground forecast system has incorporated with fishing depth to ensure the fishing efficiency of longline. The developed model predicts temperature vertical profiles to determine swimming temperature of tuna enabling to maps the depths of tuna resources.

Thus, the fishing depth is found to be an important element to be accompanied with forecast information to ensure high catch rates. Yellowfin tuna are known to preferentially occupy the surface mixed layer above the thermocline (Dagorn et al., 2006). As the mixed layer of the Indian Ocean is heavily influenced by its monsoonal wind reversals, the tuna vertical migration due to thermocline variability is significant. As a result, longline deployment is uncertain and experienced low catch rates. Therefore, prediction of temperature vertical profiles were a challenge. Thus, a methodology was developed to predict temperature vertical profile of the ocean using sea surface temperature and sea surface height information from satellite and incorporated into the existing

fishing ground forecast system (Rajapaksha *et al.*, 2014). This methodology has several limitations such as ocean surface conditions affect by wind forces and mixed layer dynamics. Therefore, a new method was developed based on the temperature profile data provided by Copernicus Marine Environment Monitoring Service (CMEMS). The CMEMS provides model based regular information on the physical state and dynamics of the global oceans in ¼° spatial resolution. It has more advantages due to its high spatial and temporal resolution as well as based on multiple data sources.

Vessel Monitoring System (VMS) has been implemented by the department of fisheries along with their logbook data collection since 2015 and the data is accessible to NARA for validation and improvement of fishing ground forecasts. In addition, DFAR will introduce electronic log book system in 2017 and this will be a reliable platform to disseminate fisheries information directly to in high seas. On the other hand, the fisheries information web portal will be a gateway to deliver fisheries information. A Web GIS System will be enables to visualize the geospatial information through internet.

Goal

Project will be contributed to Increase the economic efficiency of offshore fishery sector of Sri Lanka

Objectives

a. Improvement of existing fishery forecasting system incorporating fishery and satellites data with the following activities

- Positioned fishery data collection from tuna longline and analysis with ocean observational data from satellites and in-situ instruments
- VMS data analyses to validate and improve the existing fishing ground forecasting system.
- Incorporate oceanographic forecasting model (HYCOM) to improve forecasting accuracy.
- Fishing ground forecast mapping and information dissemination to the offshore fisheries sector

b. Development of online fisheries information services to the offshore fishery sector

- To develop online platform for fisheries information services that will be accessed by the registered users by a PC and Mobile app.
- Increase the awareness of the current status of fishery in the Indian Ocean
- To provide marketing information and current fish prices of the international market
- To provide information on fishing gears, accessories and service providers
- To provide information on illegal fishing activities, banned gear types etc.

Outputs

- Improved fishing ground forecasting system
- Updated databases for offshore fishery and oceanographic data
- Online fisheries information services

Outcomes

- Increased economic efficiency of offshore fishery sector and reduce the fishing pressure on coastal fishery resources.
- Improved capacity of fisheries related information generation and dissemination

Methodology - Project areas

Project area consist of the Indian Ocean where large pelagic fishing operations done by Sri Lankan fishermen from all coastal districts.

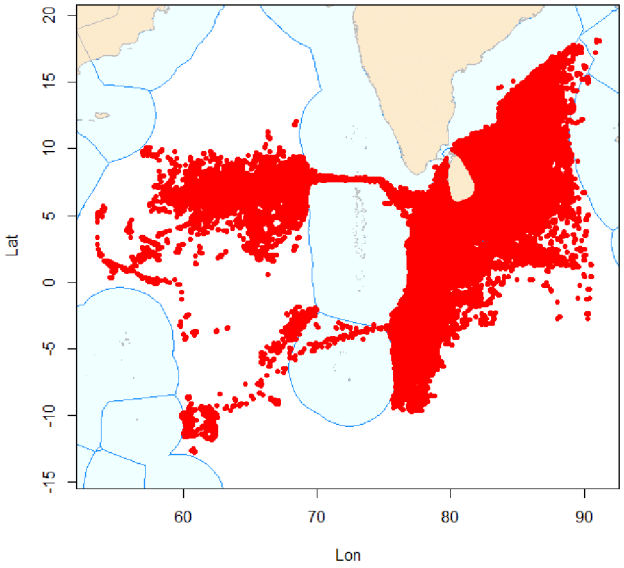


Figure 4 : Fishing extent of Sri Lankan vessels in the Indian Ocean

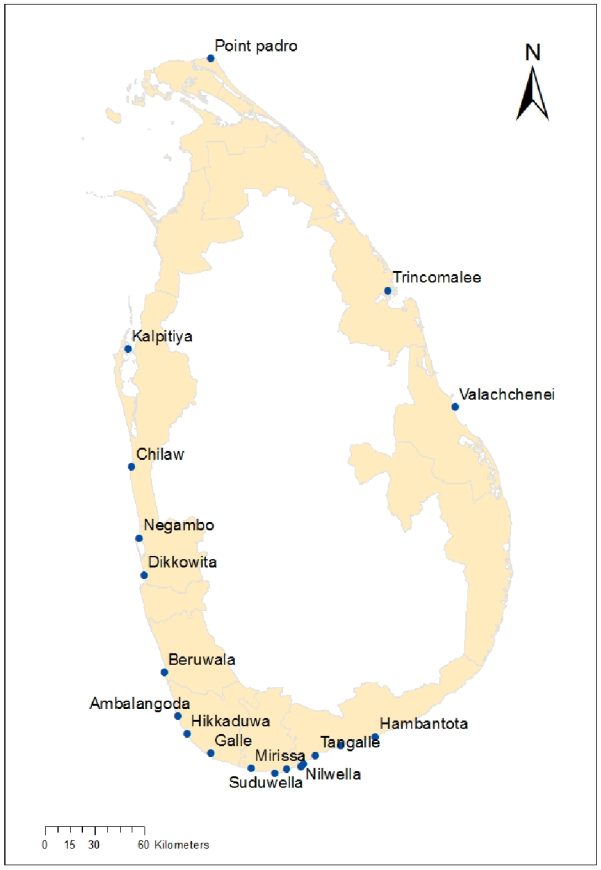


Figure 5: Harbor locations where fishery data are collected

Materials & Methods

Fisheries logbook data

DFAR have introduced logbooks in 2012 as an approach to systematic data collection system and to develop a database. Database development was initiated in 2015. Logbook data has been seen as a source of fisheries data since it became widely recorded and compiled. In many instances the catch data is used for scientific research when none is available (Thomas-Smyth, 2013). However, the logbook information has been continuously argued as unreliable and not verified as accurate. There was no cost-effective alternative to validate accuracy of fisheries logbooks until VMS is introduced.

Vessel Monitoring Systems (VMS) data

VMS identity, position, speed, and heading data from SL vessels are transmitted to the DFAR. Ping interval is set to 4 hours (default value) compliance with minimum requirements of Indian Ocean Tuna Commission (IOTC, 2015).

Sea Surface Temperature

Sea surface temperature data obtained from GPM Microwave Imager (GMI). The Global Precipitation Measurement (GPM) satellite has a microwave radiometer onboard called GMI. GMI data are produced by Remote Sensing Systems and sponsored by NASA Earth Science funding. Data are available at www.remss.com.

Absolute Dynamic Topography / Sea Surface Height

Global Ocean Gridded L4 Sea Surface Heights and Derived Variables NRT product from CMEMS is used obtain Sea Surface Height. This product is processed by the SL-TAC multimission altimeter data processing system. It serves in near-real time the main operational oceanography and climate forecasting centers in Europe and worldwide. It processes data from all altimeter missions: Jason-3, Sentinel-3A, HY-2A, Saral/AltiKa, Cryosat-2, Jason-2, Jason-1, T/P, ENVISAT, GFO, ERS1/2.

Sea surface chlorophyll

The Sea surface chlorophyll data acquire from HERMES web interface (http://hermes.acri.fr/) of Globcolour project. GlobColour data (http://globcolour.info) used in this study has been developed, validated, and distributed by ACRI-ST, France.

Global Ocean Model data

The Copernicus Marine Services (CMEMS) provides regular information on the physical state and dynamics of the global ocean. Global ocean ¼° physics analysis and forecast product is updated daily and provide temperature of 43 vertical levels. Global physical analysis and coupled forecasting product includes daily mean files of temperature, salinity, currents, sea surface height, mixed layer depth and sea ice parameters. It is freely available for registered users at Copernicus Marine Service website (http://marine.copernicus.eu). This product is generated by the UK Met Office Global Seasonal coupled forecast system (GloSea5) which is used to provide 7 days of 3D global ocean forecasts, at ¼ degree, updated daily (MacLachlan *et al.* 2014). This forecast product is assimilated observations of SST data from Advanced Very High-Resolution Radiometer (AVHRR and MetOp satellites supplied by the Global High-Resolution Sea Surface Temperature (GHRSST) project. In-situ SST from moored buoys and drifting buoys and ships, Sea level anomaly observations from Jason2 and CryoSat2 were assimilated. Sub-surface temperature and salinity profiles from Argo profiling floats, underwater gliders, moored buoys and manual profiling methods were used. The Global

Ocean output files are displayed with ¼°horizontal resolution with geographic projection. It also provides 75 vertical levels ranging from 0 to 6000 meters (Table 1).

Table 1: Depth levels and intervals of Global ocean ¼° physics analysis and forecast product

Depth range (m)	0-50	50-100	100-250	250-300	300-1500	1500-3500	3500-6000
Interval (m)	5	10	25	50	100	250	500

Fishing ground forecasting

Sea surface properties such as temperature, chlorophyll, height, velocities are derived from Satellite observations. Subsurface temperature, mixed layer depth, velocities are obtained from ocean modeled data, downloaded from CMEMS analyses. Those data are processed three times a week to generate maps of potential fishing grounds. Multi-criteria decision-making model was developed based on fuzzy logic theory under previous studies was used to predict potential fishing grounds for tuna. This output is coupled with a model described in the next section which integrate fishing depths to the final map product for dissemination.

Fishing Depth Prediction

A mathematical Model was developed to predict swimming temperature of tuna with preferable temperatures which was found by previous researches. These depths were resampled to 1-degree resolution to integrate with the forecast maps. The main steps of the procedure are depicted in Figure 3. This analysis was conducted by R statistical software 3.2.1.

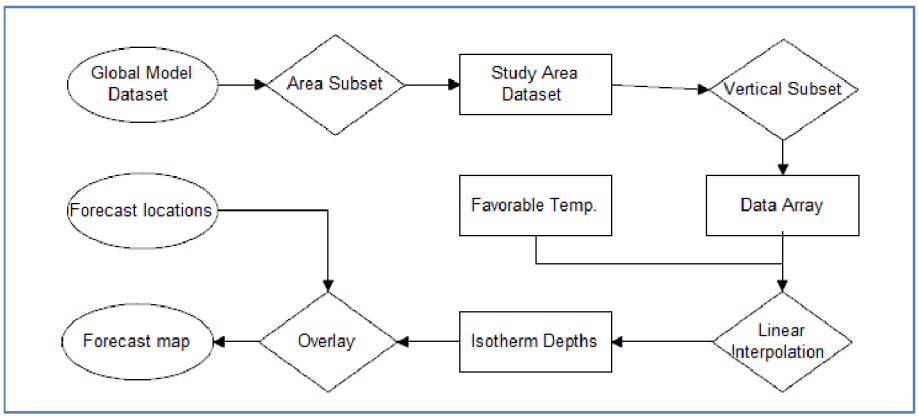


Figure 6: Flow chart showing the stepwise methodology for fishing depth prediction

Fishery data collection

- Structured Interviews and questioners for fishermen
- VMS data
- Fisheries logbooks data from DFAR
- Fishery data from landings to collect data from boats which are VMS unregistered

Results

Tuna fishing ground forecast

Total number of fishing ground forecasts produced were about 105 those disseminated via fax, email, telephone and SSB radio during the year-2017. Since February 2017, forecast map was disseminated through *"Puwath satahana"* program on ITN every Thursday and Saturday at 0700 am.

The number of fishing ground forecast was 2 times per week and it was increased 3 times per week from April 2017.

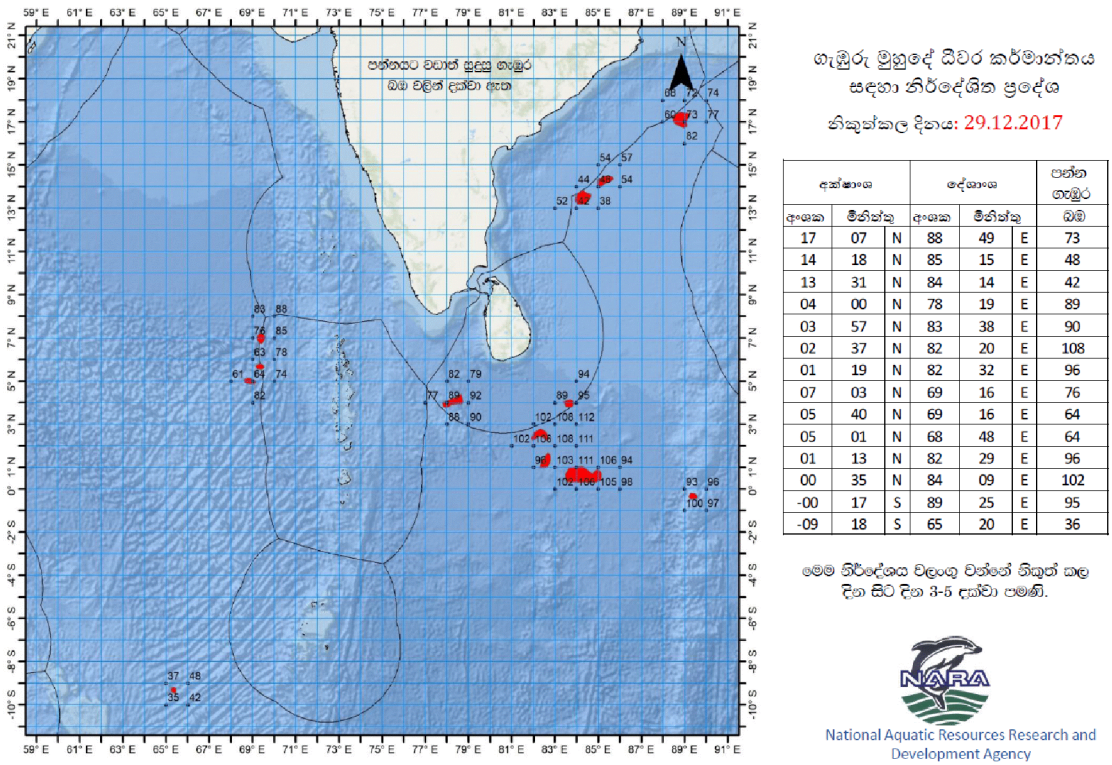


Figure 7 : Tuna fishing ground forecast on 29.12.2017

Fishing Depth Prediction for Tuna Longlines

The depth layers were extracted up to 400 m from CMEMS model and output of the isotherm (25.5°C) depth is shown in the figure 2a. In the tropics, we can observe high variability of isotherm depth due to high mixing rates and can be expected seasonal variability as well due to monsoon climate. Figure 2b shows the isotherm depth associated with the predicted tuna fishing grounds.

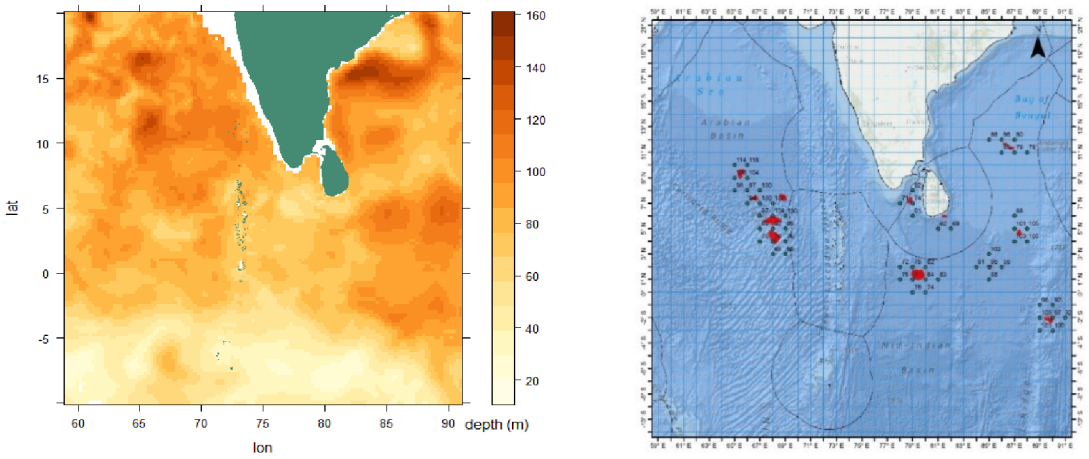


Figure 8: Isotherm (25.5°C) depth predictions for study area (a) on 02 May 2017 and tuna forecast map that incorporated with fishing depth (b).

Fisheries database was updated with VMS data from January 2017 to December 2017 and Fisheries log book data of 2016. Questioner surveys and awareness interviews have been conducted on Dikowita, Negambo, Beruwala, Galle, Mirissa, Devinuwara, Nilwella, Kudawella and Tangalle fisheries harbors. E-mail user community has been improved twice since 2016 and more than 180 fishermen and fisheries officers are receiving fisheries advisory.

Discussion

Tuna fishing ground forecast

Fishing ground forecasting and dissemination has been improved during 2017 with incorporation new fishing depth methodologies, improved maps and dissemination methods. Monochromic maps were replaced with color topographic ocean maps. Dissemination process was improved by collaboration with ITN, Sri Lanka for television service provider.

Fishing Depth Prediction for Tuna Longlines

This methodology has improved spatial coverage and temporal resolution over the existing model that has been used for fishing depth prediction. Data unavailability issue was solved for predicting by the CMEMS model. With the new method, fishermen will be able to use the most appropriate fishing depths for longline deployment.

Limitations

Operational fishing ground forecasting is depending on availability of near real-time satellite data and global physical forecast products. There were several occasions that service breakdowns caused interruption of project activities.

Availability of accurate fishery data is crucial for the results of this project. We receive logbook data once a year from DFAR. It will be highly appropriate, if NARA has direct access to DFAR database. It would be important, if NARA has a direct link to VMS system.

The accuracy of predictions can be improved significantly with in-situ data collection by temperature, depth sensors attached to longline fishing gear. The procurement process for temperature and depth recorders has been continuing throughout year 2017 and beyond. It would have been good is highly recommended to give a priority to purchase these directly from manufactures.

The fisheries information web portal is essential for dissemination of fisheries information to a wider group of stakeholders. This portal was planned to implement during 2017, but unsuccessful due to lack of expertise and funds.

Conclusions

CMEMS global physical analysis was successfully coupled with existing tuna fishing ground forecasting system to predict the depth of tuna preferred temperature.

Fishermen should be acknowledged for their data recording in logbooks which is valued fishery-dependent data source and should encourage for accurate data recording.

Recommendations

Incorporate ocean physics models and in-situ information to improve prediction. As our current fishing ground advisory based on near real-time data, it would be highly advantageous, if we could provide fishing ground advisory based on forecasted ocean conditions for few days ahead. Thus, fishermen will be able to plan their cruise based on advisory and ultimately receive more economic benefits than just roaming for fishes here and there in the ocean.

Awareness of Skippers and owners of multiday fishing boats about PFZF of Nara will be key factor to success of project. Therefore, awareness programs should conduct frequently.

VMS and logbook dataset need to process and analyses for accuracy assessment of fisheries logbook data and improvement of Tuna fishing ground forecasting system of NARA.

Summary

Fishing ground forecasting and dissemination has been improved during the year 2017 with incorporation of fishing depth prediction new methodologies. Monochromic maps were replaced with color maps. Dissemination process was extended by collaborating with ITN channel of Sri Lanka television.

Data unavailability issue was solved by new source of data from CMEMS ocean modeled datasets. CMEMS global physical analysis was successfully coupled with existing tuna fishing ground forecasting system to predict the depth of tuna preferred temperature.

Our current forecast is based on near real-time data. Next generation of the forecast would be based on forecasted ocean conditions for days or weeks ahead. Awareness of Skippers and owners of multiday fishing vessels are key factor to success of implementing this project.

VMS and logbook dataset were processed and analyzed to evaluate the accuracy of logbook records and found that 40% of data are not reliable. DFAR is informed the situation and they have taken action to aware the fishermen and improved the data recording accuracy.

As expected outputs, fishing ground forecasting system was improved and fishery and oceanographic databases were updated, however, online fisheries information service could not established.

Publications produced

1. **Gunasekara, S.S.**, and **Rajapaksha J.K.**, 2017. Fishing depth prediction for tuna longlines; An improved fishing ground forecasting system for Sri Lanka. National Aquatic Resources Research and Development Agency (NARA), Scientific Sessions 2017, At National Aquatic Resources Research and Development Agency (NARA), Crow Island, Colombo 15, Sri Lanka.

2. **Gunasekara, S.S,** Rathnasuriya, M.I.G., 2017. Best Practices in Releasing of By-catch of Sensitive Species in Sri Lankan Tuna Multi-day Fishery. Scientific Sessions of the Sri Lanka Association for Fisheries and Aquatic Resources, At National Aquatic Resources Research and Development Agency, Colombo 15. Sri Lanka, Volume: 23

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PROJECT NO : 1.5.2

OPERATION OF OCEAN OBSERVATION CENTER AND SEA LEVEL MONITORING STATION

Responsible Officer : Dr. K. Arulananthan

Introduction

The 24x7 Ocean Observation Centre (OOC) was established in March 2007 to observe, monitor, predict and forecast Tsunami and to share necessary data and information to the Disaster Management Centre for Tsunami warning Dissemination. The Disaster Management Centre established a 24x7 observation centre, thus to avoid duplication of work, the 24x7 observation centre, operated by NARA is closed and the Center is to be transformed as an Ocean forecasting Centre.

The Ocean Forecasting Centre is working to develop, implement and observing system for monitoring the real time and near real time ocean conditions around Sri Lanka waters. Main goal is to implement an end-to-end system with the capability to detect, model and ultimately forecast changes in the ocean conditions around Sri Lanka Waters. In 2017, Ocean observation Centre had focused on observation of sea level, wind and wave condition and prediction. Globally, sea-level is intended to increase due to the global warming.

Activities

Ocean Forecasting centre had commenced simulation of regional wave forecast and able to predict regional phenomena reasonably well. The trained staff had difficulties in running Tide models due to poor processing capacity of computer available at NARA and also due to insufficient theoretical background.

Mirrisa Seal Level Station construction is completed in February, 2017. Meteorological and hydrological sensors were installed at the newly constructed Mirrissa sea level station and set up communication system to transfer data from the Mirrissa sea level station to Head office of NARA in Colombo. Furthermore, a User Friendly Interface (UFI) was installed for the easy display and archival of the meteorological and hydrological parameters from the Mirrissa sea level station.

Data from the Mirrissa sea level station is retrieved and in the processes of preliminary processing of different parameters; water temperature, water level, wind speed, wind direction, air temperature, relative humidity, air pressure and precipitation.

Quality controlling of water temperature, water level, air temperature, relative humidity, air pressure and precipitation completed. Preliminary analysis of wind direction and wind speed data seems to have excessive channeling effect, however the data need to be further analyzed for any conclusion.

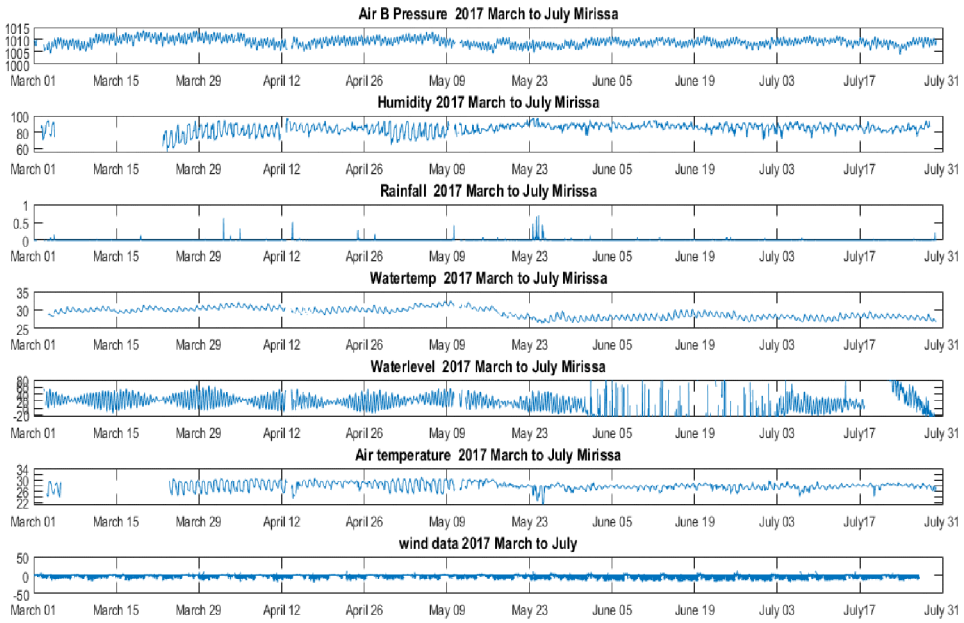


Fig.1 Meteorological and hydrological parameters observed at the Mirissa sea level station, March 01 – July 31, 2017

Air pressure: Diurnal fluctuation amounts to 5 mb and shows a drop of 2-3 mb with the on set of summer monsoon.

Air temperature: Diurnal fluctuation is high during the inter monsoon amounts to ~ 5 oC with a daily mean average of ~ 28 oC. The air temperature reduces to 22oC on the day of monsoon on set. The monthly mean average air temperature and diurnal temperature fluctuation are reduced during the southwest monsoon.

Water temperature: Diurnal temperature fluctuation during the inter monsoon (~1oC) is comparatively less than the fluctuation during the southwest monsoon (~2oC). Moreover, there is a marked decrease (~2oC) in water temperature with the onset of southwest monsoon.

Quality controlling of water level data is not yet completed, while further analysis is required in respect to wind speed and wind direction data. The quality controlled sea level data is incorporated and compared with the sea level data (Colombo). The data will be further analysed to compare the rate of sea level rise on the west coast and south coast.

The malfunctioned atmospheric temperature sensor was replaces and a new atmospheric sensor was fixed in June 2017.

The temporary tide well, made of fiberglass was replaced with a stainless steel well. The broken "axial arm" of the floating gauge is replaced with an "axial arm" in October 2017

In November 2017, the water temperature sensor was cleaned from bio-fouling. Furthermore, additional anchorage facilities were made available to the fishermen, who had lost their anchorage facility due to the construction of the sea level station. Furthermore, protective guard for the station is constructed to safeguard the construction from anchored boats and a photo sensitive light is fixed at the vicinity of the station.

Trainings

Mr. Akila Harichandra and Ms. K.W.A. Kashmila had attended a training course on numerical model, held in Qingdao, China during December 26, 2016 – January 22, 2017. The two NARA staff were taught theory of dynamical oceanography and trained on "Princeton-MASNUM- Ocean Model" for simulation of regional wave and tide. The model is run for capturing major events such cyclone and storm surges. The tidal model is capable of predicting tide any specific site.

Mr. K. W. Indika and Ms. G.D.P. Niroshani, attended a "Training course on database management of hydrological and meteorological station at Mirrissa Fisheries Harbour", held in Qingdao, China during May 14-18, 2017. The two staff were trained on communication via local communication system through a wireless router, setting up a wireless router with a personal computer, setting up a personal computer using permanent IP address to logging remote computer which is known permanent IP address and installation and setting of user friendly interface (UFI) for the Mirissa permanent meteorological and hydrological station.

Recommendation

- The trained Staffs are not able to progress from regional forecast to site specific local forecast due to poor processing capacity of computer available at NARA and also due to insufficient theoretical background. Computer processing capacity shall be enhanced and the assigned staff shall be further trained through short term trainings.

- Mirrissa sea level station shall be integrated with an offshore wave data buoy, thus made as a comprehensive observation system. Possibilities of incorporating radiation sensors shall be explored.

- Sri Lanka now operates three sea level station strategically located on the west, south and east coast, however the there is a need to establish a sea level station on the northern coast.

- Capacity for site specific wave and ocean currents forecast shall be built up.

PROJECT NO : 1.6.1

SPATIO-TEMPORAL VARIABILITY OF HYDROGRAPHY AT SOUTHWESTERN AND EASTERN COASTS OF SRI LANKA

Responsible Officer : Mr. S.U.P Jinadasa
Mr. Akila Harishchandra
Dr. H.B. Jayasiri

Introduction

Sri Lanka is a tropical country located at the northern Indian Ocean (IO), south east to the Indian sub continent. It is located at the causeway right between two significant enclosed water bodies (Arabian Sea(AS) and the Bay of Bengal(BoB)) which the northern marginal seas of IO. AS and BoB are comprised with two different set of hydrographic characteristics. AS has an annually averaged high sea surface salinity (SSS) (36 PSU) and relatively low sea surface temperature (SST) (27 0C) than BoB. Meanwhile BoB has a averaged annual SSS of 30 PSU and a high annual averaged SST as 280C. BoB freshwater input (Evaporation -River runoff) is higher than AS due to excess fresh water input (7.1X1012 m3y-1) which are carried by the major rivers of India (Godawari, Yamuna, Brahmaputra etc) and Bangladesh (Irawaddi). Although AS has less rain and high evaporation rate makes a small fresh water input than BoB. Accumulated freshwater load in head of BoB is carried towards the AS by a current modulated by North East Monsoon (NEM) wind, along the east coast of India and Sri Lanka which is called as East Indian Coastal Current (EICC) during the NEM period (December to February). This freshwater load which is carried by the EICC plays a major role in the dynamics of Air Sea Interactions in IO, hence to the climate changes in IO and the whole world.

Along with the passage of EICC along the east coast of Sri Lanka, it is suspected that the biological and chemical environment should be modulated. It could be inferred that the fresh water flow from Indian coast change the SSS at the east coast, hence a simultaneous changes in PH, nutrient level and productivity. A recent study conducted by NARA identified that the SSS at east coast drops to 26 PSU from an annual average value of 33 PSU during November month. It could be a possible evidence for the transportation of fresh water tongue which is carried by the EICC. However the changes in other biological and chemical parameters are not well known and less studied. Also, few global and regional models expressed an idea that a part of this EICC bifurcate through the Palk Strait, flowing along the east coast of Sri Lanka. But such an idea is limited only to model simulations; no any actual observation has recorded.

So, this study has planned to study the changes in biological, chemical and physical environment of east and north coasts of Sri Lanka.

Methodology

To study the biological, chemical and physical environment of the east and north coast of Sri Lanka two locations from both coasts were selected to conduct the initial survey. 10 sampling points at a 20 km survey line which are departed by 2 km spacing were proposed to collect samples. One line was located at the east coast along the 8.58 ^{o}N longitudinal line and other one in Jaffna peninsula was located along the 80.23 ^{o}E latitudinal line. Both lines were perpendicular to the shore line (Fig. 1).

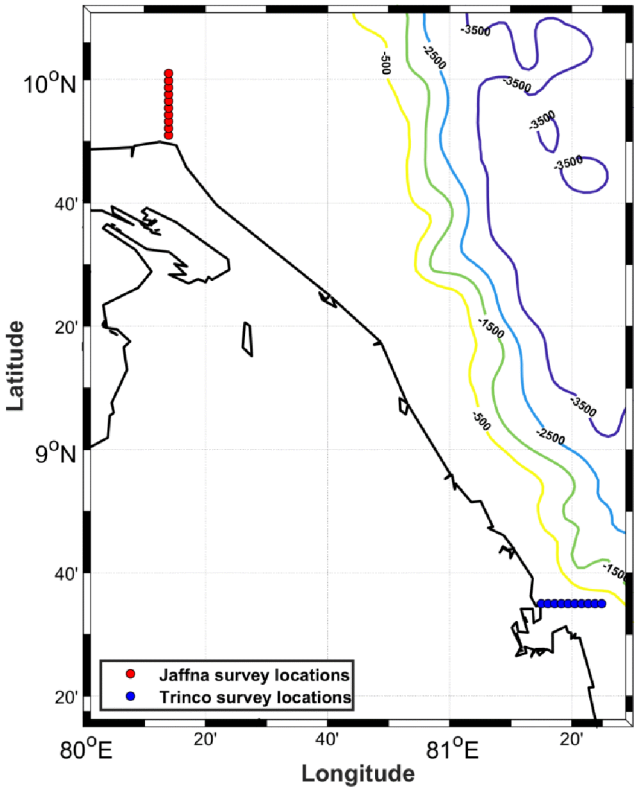


Fig.1. Locations of the sampling points

August to November time period was selected to conduct sea going data collection, as only this period permits near shore boat operations. In the other periods, strong North Easterly winds hits the north and east coasts of Sri Lanka, terminating most of sea going activities in both coasts. A locally available small scale Out Board Motor engine boat was used to go to sea.

Temperature and salinity data were collected representing the physical oceanographic parameters, while chlorophyll data were collected to understand the primary productivity which represents the biological component for this study and nutrients (nitrate, nitrite, phosphate and silicate) were analyzed for this study to understand the chemical properties of the ocean.

Conductivity, Temperature and Depth Profiler (CTD) which is designed to collect temperature, salinity values at different depths was used to collect temperature and salinity data. A CTD which is manufactured by Sea Bird Electronics at USA (Model SBE 19+) was used to collect data. It was operated by hand for this study. Flurometric data which was captured by the flurometer attached to the CTD also used to calculate the chlorophyll concentration at survey locations. Water samples were collected to be analyzed later at the Oceanography Division laboratory for nutrient data.After the data collection, CTD data were quality controlled by following standard quality control protocol adapted by the manufacture. Later on, all the data were analyzed and plotted by using MATLAB and MS Excel for further analysis.

Wind data were retrieved from the European Center for Medium Range Weather Forecast (ECMWF) to analyze the along track wind speed and direction.

Results

3.1 Ocean dynamics at east coast of Sri Lanka.

3.1.1 Temperature variability.

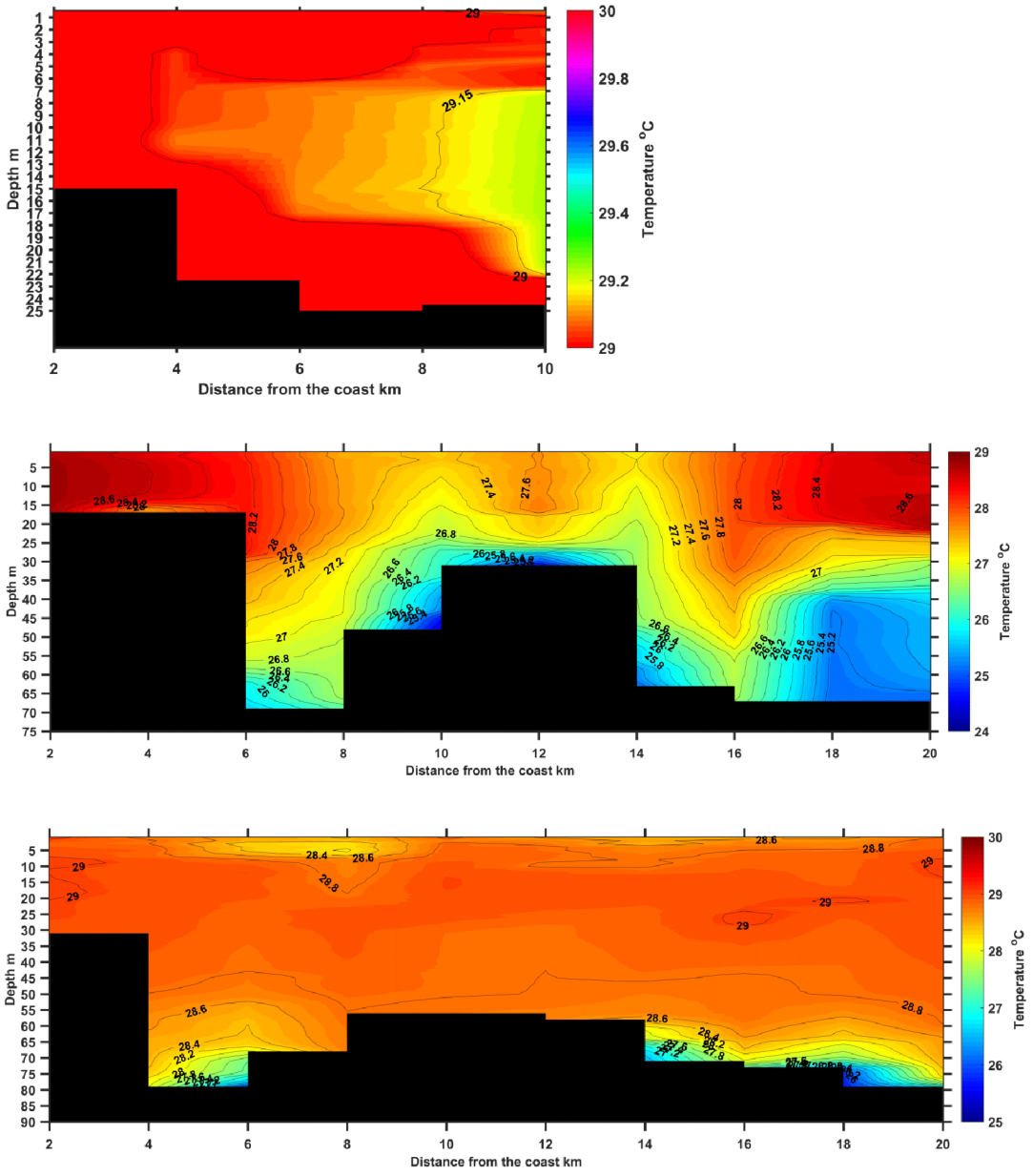


Fig. 2 Temperature variability at the east coast during August, September and October 2018.(Top to bottom respectively).

Figure 2 shows the temperature variability along the survey line during August, September and October 2018. The first figure expresses an idea that a subsurface warm water flow regime which could be observed at places where barrier layer form. In the other time, there was no significant change in temperature variability. Temperature fluctuated between 25-30 °C.

3.1.2 Salinity variability at east coast.

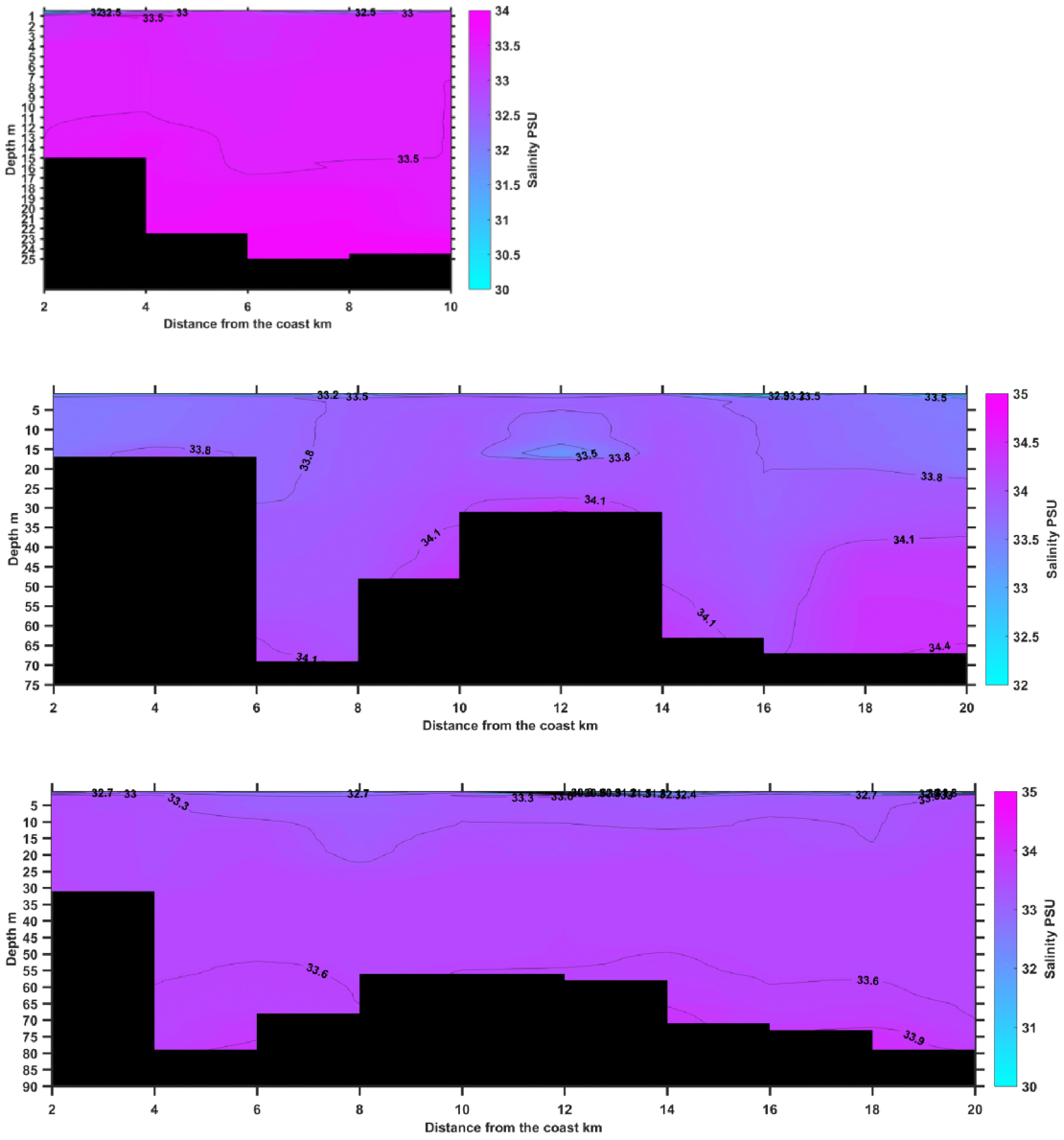


Fig. 3 Salinity variability at the east coast during August, September and October 2018.(Top to bottom respectively).

Figure 3 showed how salinity changes with the time along the survey line. Salinity varied between 30-35 PSU and there was no identified significance of salinity variability from its general distribution pattern.

3.1.3 Density variability.

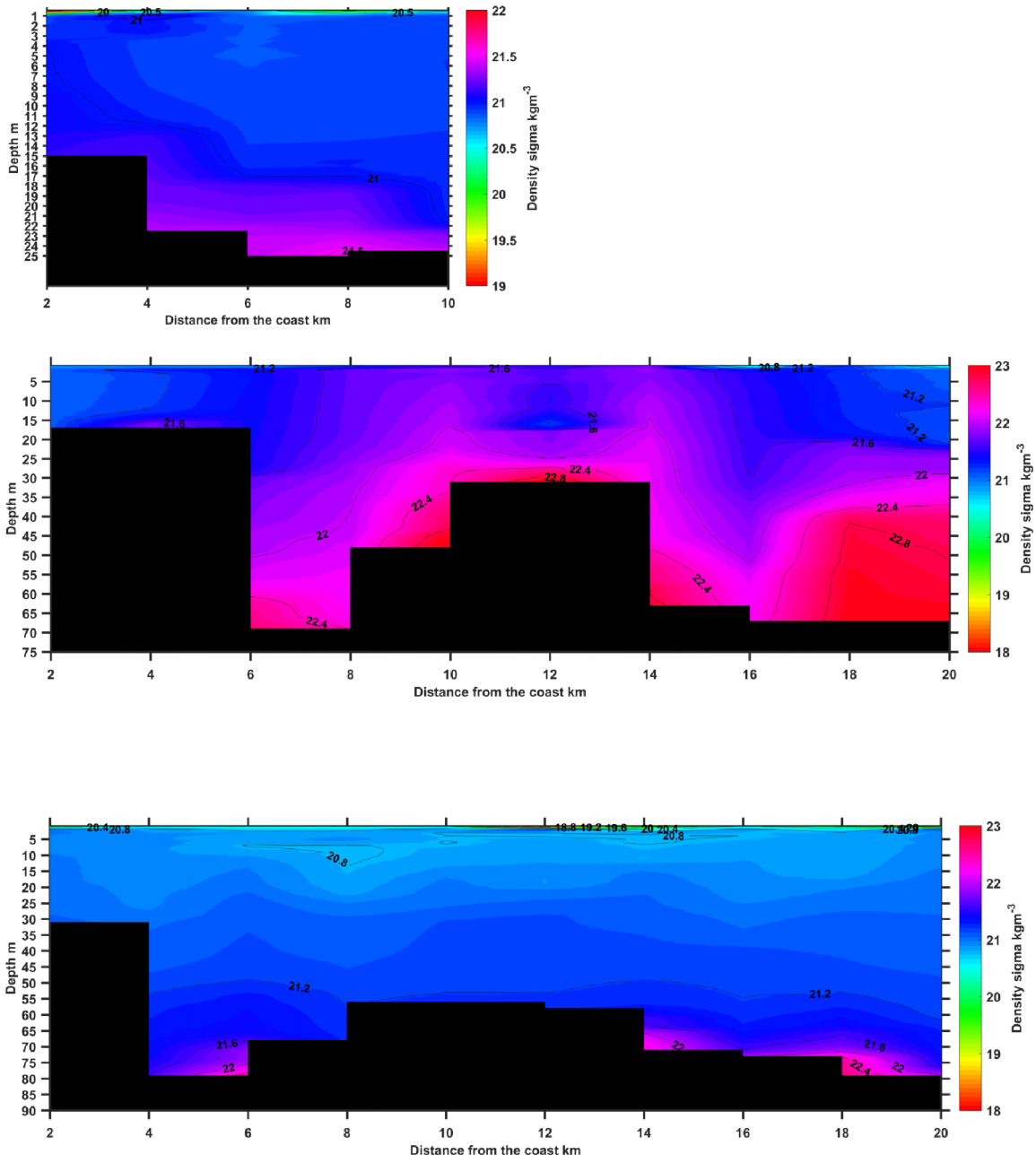


Fig. 4 Density (sigma) variability at the east coast during August, September and October 2018. (Top to bottom respectively).

Density sigma (In situ density -1000) was varied between 20-22 kgm^{-3} during the whole study. It was clearly figured that the water column was strongly stratified during the study period thus the static stability was high. It makes a possible barrier for vertical mixing.

3.1.4 Chlorophyll concentration at the east coast.

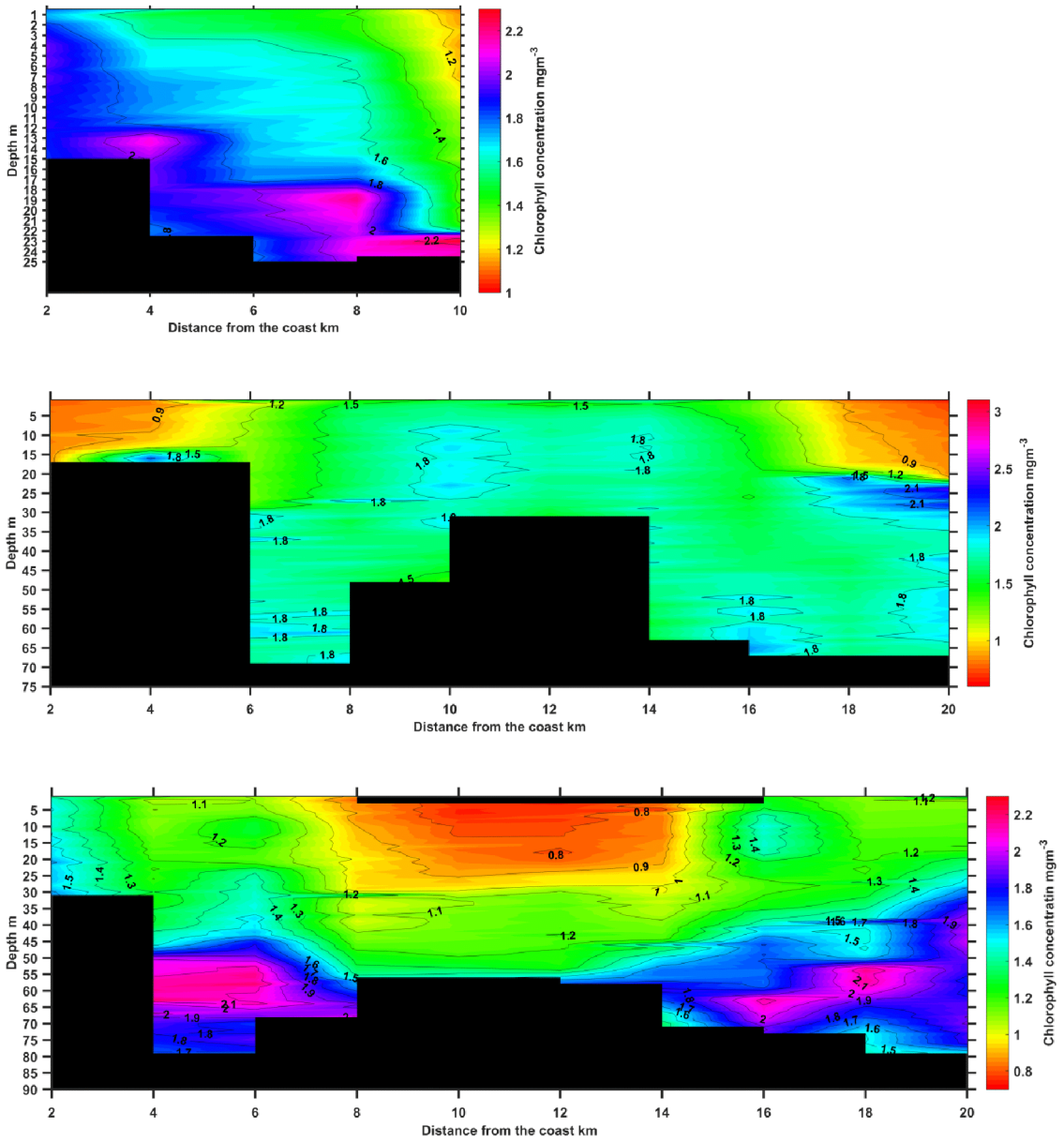


Fig. 5 Chlorophyll concentration variability at the east coast during August, September and October 2018. (Top to bottom respectively)

Figure 5 shows how chlorophyll concentration varied with the time and depth. However the first figure showed that the coastal area was much productive than the offshore area which has higher chlorophyll concentration (2 mg/m^3) than the offshore concentration (1.2 mg/m^3). During the September month there was an elevated chlorophyll layer existed at the 10-12 km offshore area, looks like a possible sign of upwelling. But at the last month (October) such condition was reversed, a low chlorophyll patch existed at the same area. Subsurface Chlorophyll Maxima was observed at October, existed at a depth below 40m.

3.1.5 Nutrient condition of the eastern ocean.

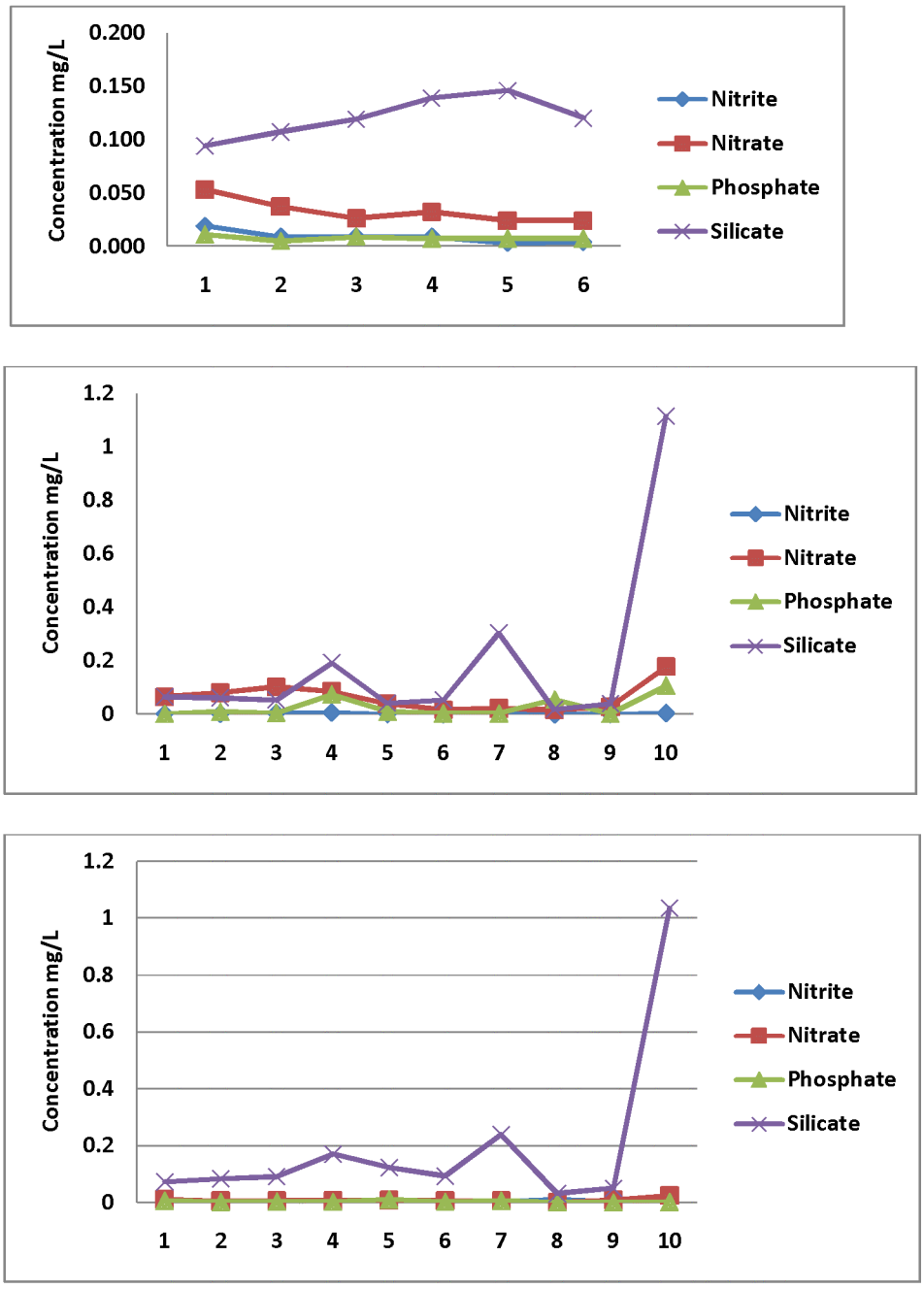


Fig. 6 Nutrient concentration variability at the east coast during August, September and October 2018 (Top to bottom respectively)

Among the four different nutrient groups studied in this study, Silicates were the dominant group. During August coastal nitrates, nitrites and phosphates showed a seaward declining trend. Contrast,

silicates increased seaward. In September all nutrients except silicates, showed a wavy fluctuation, decreasing trend towards the middle of the survey line, then onwards increased offshore ward. However the level of silicates were much higher than other three groups. Same condition appeared in October, a high peak in silicate observed between 18 and 20 km offshore area.

3.1.6. Wind regime of the area.

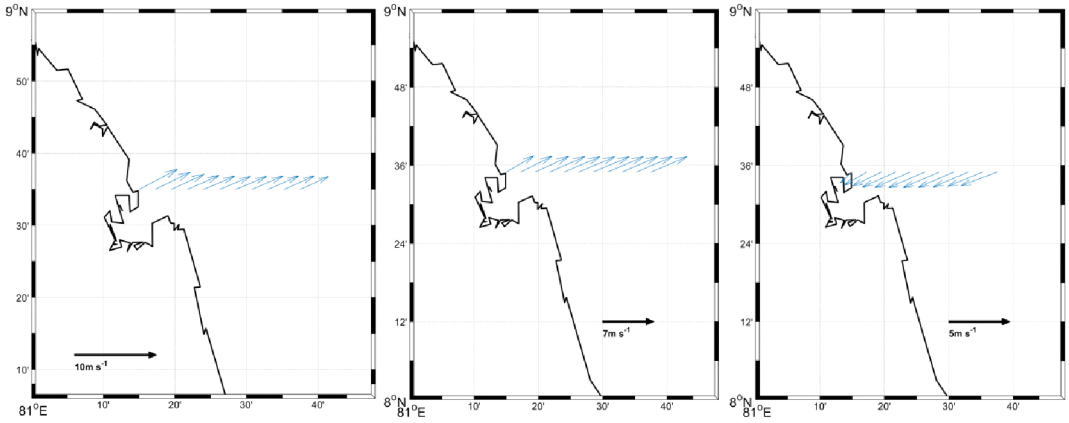


Fig. 7 Prevailed along track wind regime in August, September and October (From left to right respectively).

Wind is a major factor which could force the coastal upwelling to moderate the bio-physical environment of the local upwelled area. So, along track wind pattern was studied in this study. During August, prevailed South West monsoonal winds crossed the country and left Sri Lanka towards the Bay of Bengal along the east coast of Sri Lanka. Wind was North Easterly and speed was approximately $8ms^{-1.}$ Wind speed gradually decreased with the time, at September it was 7 ms^{1}, but direction was same as August. In October wind was slow ($5ms^{-1}$) but the direction reversed, it was south west ward.

3.2 Ocean dynamics at north coast of Sri Lanka.

3.2.1 Temperature variability at the northern coast.

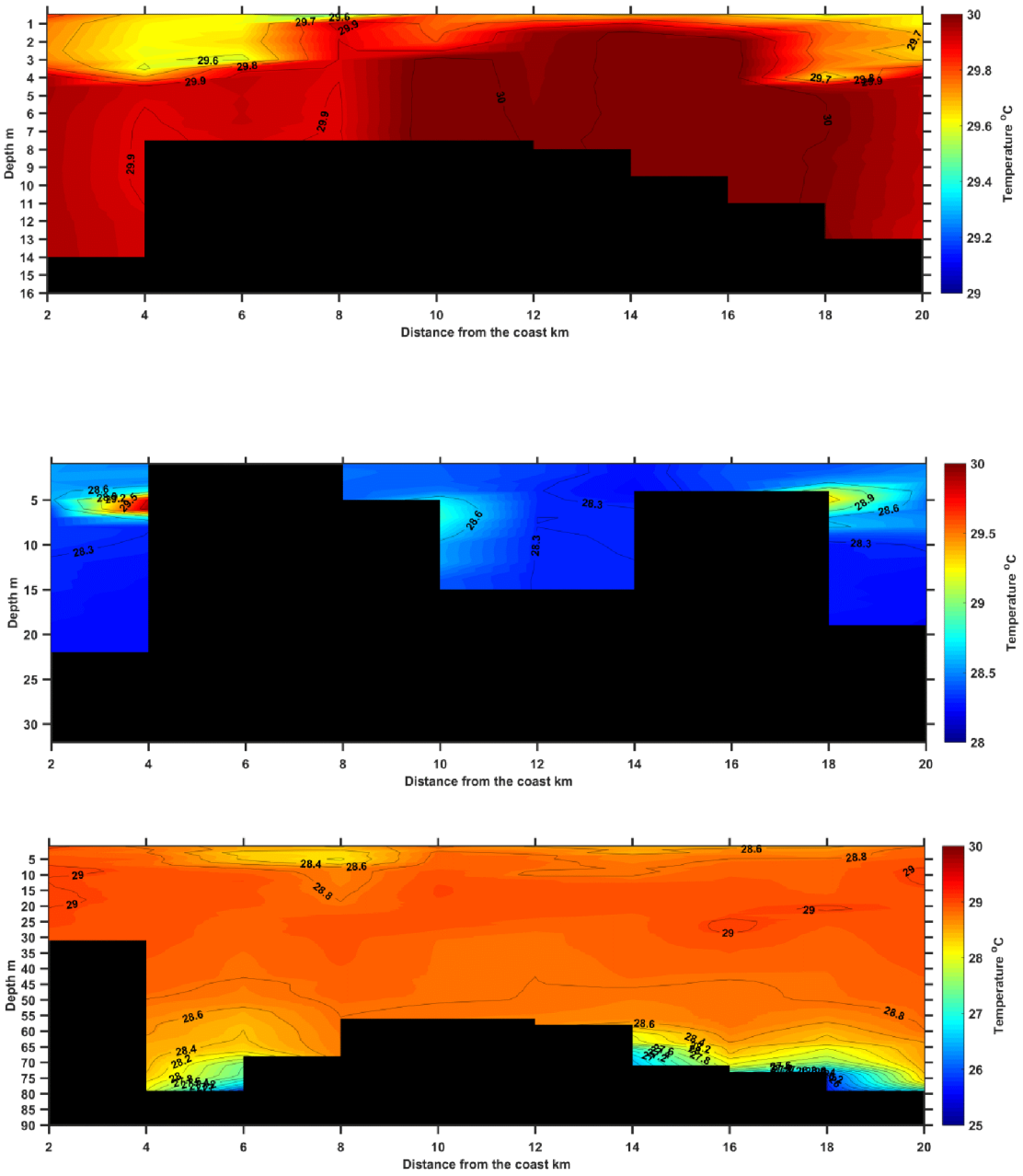


Fig. 7 Temperature variability at the north coast during August, September and October 2018 (Top to bottom respectively)

These figures showed that the temperature variability in both August and October did not deviate from the general temperature distribution pattern, but in September it showed a sub surface warm water layer. Because of a missing profile data, this subsurface warm water layer is not well observable; however a warm layer is visible. Temperature was varied between 27-29 ^{o}C.

3.2.2 Salinity variability at the northern coast.

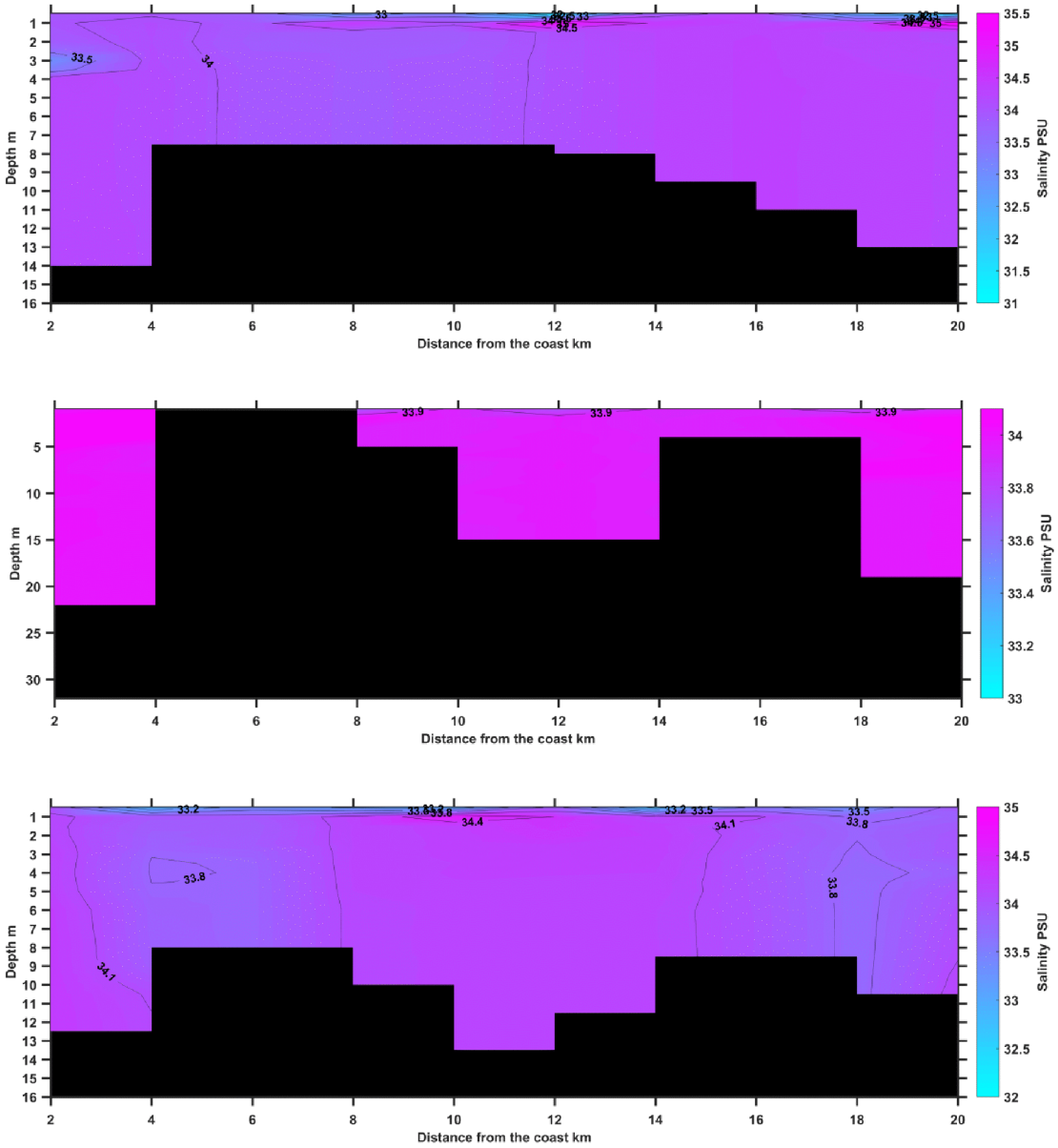


Fig. 8 Salinity variability at the north coast during August, September and October 2018 (Top to bottom respectively)

Salinity variability in northern coast during these three months was almost general, which has not shown much greater variability. Salinity has ranged between 32-33 PSU.

3.2.3 Nutrient variability at the northern coast.

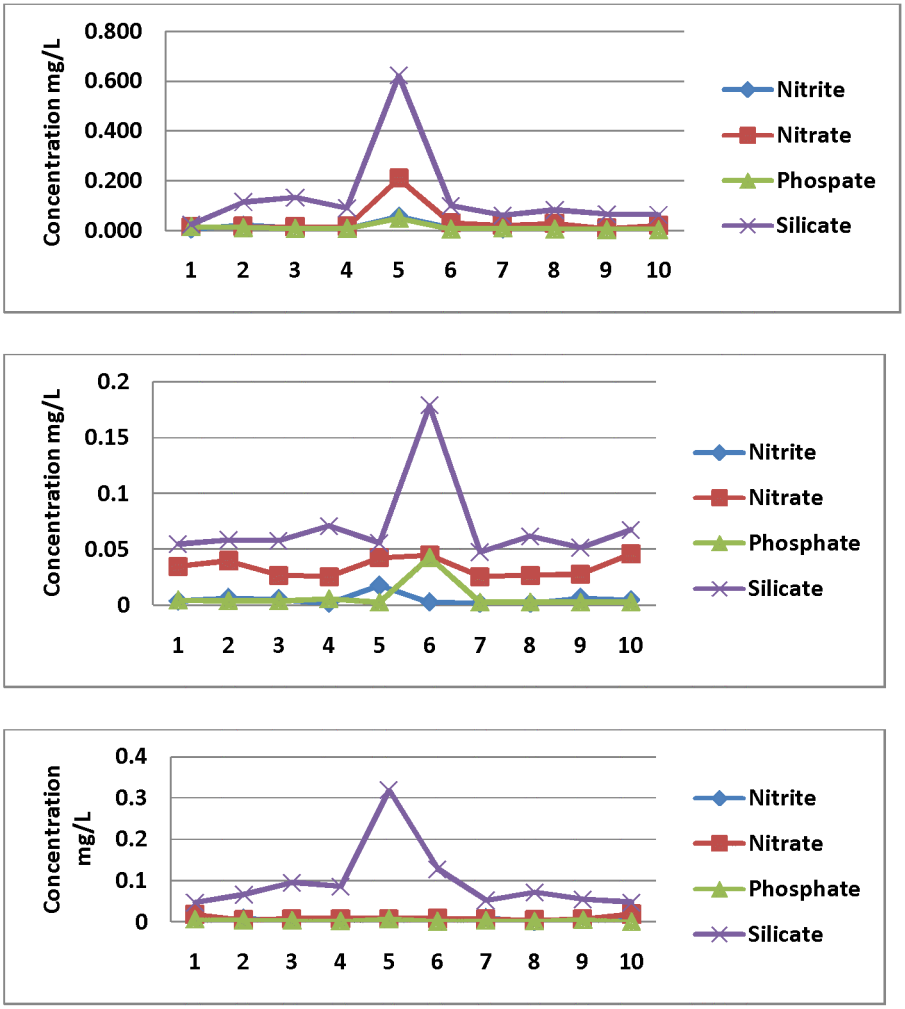


Fig. 9 Nutrient variability at the north coast during August, September and October 2018 (Top to bottom respectively)

It is observable that silicates were the most dominant group of nutrients in the area. Also, it was interesting that the all nutrient groups showed an elevation at the area between 5-6 sampling points (10-12 km offshore area). Silicates expressed the remarkable deviation, simultaneously other groups did so. Next to silicate, nitrates were the most abundant nutrient in Jaffna waters.

3.2.4 Wind regime at the northern coast.

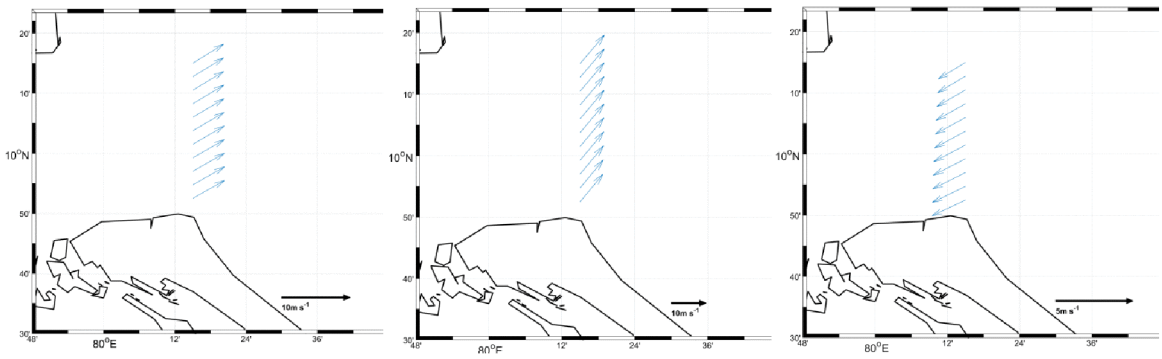


Fig. 10 Wind regime at the north coast during August, September and October 2018 (Top to bottom respectively)

During August and September, wind was north easterly and speed was 6ms^{-1} in August and 9 ms^{-1} in September. During October, wind has reversed and direction was south westerly. Speed was calmer than other two months (3 ms^{-1}).

Discussion

Salinity, temperature, density, chlorophyll concentration and nutrient levels in August, September and October months in east and north coast of Sri Lanka were analyzed in this study. According to the observations salinity, temperature, density, chlorophyll concentrations or nutrients showed minimal depth wise meridional or zonal variability. However there was little local variability, which could alter the local area ocean productivity. Further studies would be ideal to explain that variability and their correlation with fish productivity of the area.

EICC generally flows along the east coast of Sri Lanka during end of November. NARA research team visited the same area to collect data at the end of November month, but because of the heavy winds generated by cyclone 'Orchy', sea going activity had to terminate. It caused to loss of a valuable data set regards to the changes in ocean environment associated with low saline water moment. However the measured SSS at near location of east coast during this field visit (26.4 PSU) showed that the EICC flowed along the east coast. Nonetheless samples for other parameters were not collected. Because of the same reason, data collection at northern coast during this period was not conducted.

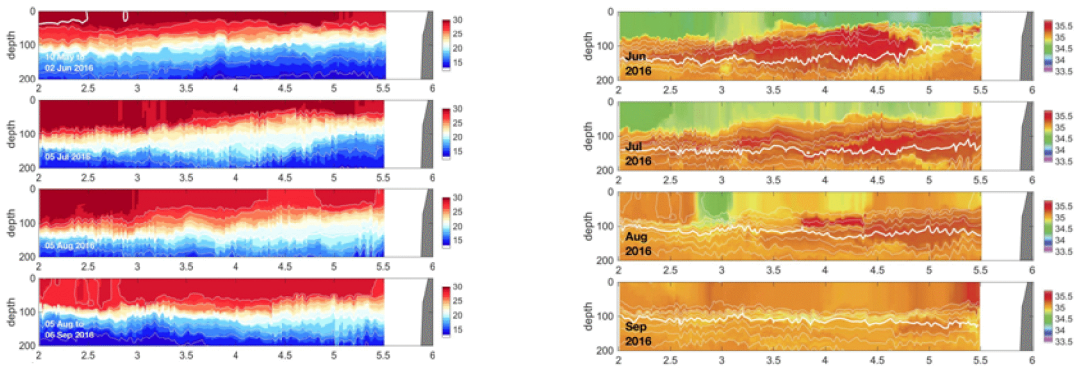
Salinity changes in November month is an important parameter to elucidate the moment of EICC along the east and north coast. But due to the high wind action caused by North East Monsoon, sea going field visits are merely challenging. A best solution for such hindrances is to fix automatic data loggers in a safer ocean area at these beaches. There are high tech instruments which can record salinity, temperature, Ph, chlorophyll and nutrient levels. Such an instrument can record the data automatically, and then a field observer can retrieve the data at a convenient time. So, instrumentation is highly recommended for this project to see a successful ending.

Introduction

The project on spatio-temporal variability of hydrography at southwestern and eastern coasts of Sri Lanka originally designed to carry out offshore Oceanographic studies around Sri Lanka. During the project we expect to collect remotely sensed data as well as in-situ measurements using R/V Samuddrika vessel. However, the Samuddrika vessel was not available throughout the year due to technical default of the vessel. So, we used seaglider data for this research.

To study spatio temporal variation in the off south coast of Sri Lanka, Sea glider was deployed at 5.5ºN and 80.5ºE. Seaglider is consists of sensors of Temperature, salinity, pressure, current, fluorescence (Chl, CDOM). To completion of a cycle it goes to 0-1000 m and ~6 km distance. approximately it takes ~6 hours to complete a cycle. The horizontal and vertical velocities of the instrument are ~0.25 m/s and ~0.1 m/s respectively.

Results



(a) (b)

Fig. 1. (a) and (b) temperature and salinity variation along the seaglider trajectories (June to September).

Fig. 1(a) and (b) shows glider data derived temperature and salinity vertical sections up to 200m depth. Temperature sections show deepening of higher temperature towards deeper depths (2º to 5º). Lenses of temperature could be observed in between high and low temperature layers.

Fig. (b) shows vertical section of salinity from the glider data. Salinity sections clearly indicated that the high and low salinity fronts. The salinity fronts shifted towards higher latitudes temporally from June to September and disappeared at the end of September. Such types of fronts are important for fishery ground identification.

The current seaglider was traveled up to 2 degrees with up and down movements during the period of 9 months (January to September). During the whole trajectory, more than 900 up and down cycles were completed. Based on the data collected during the period, total volume transport between the Bay of Bengal and Arbian sea was calculated.

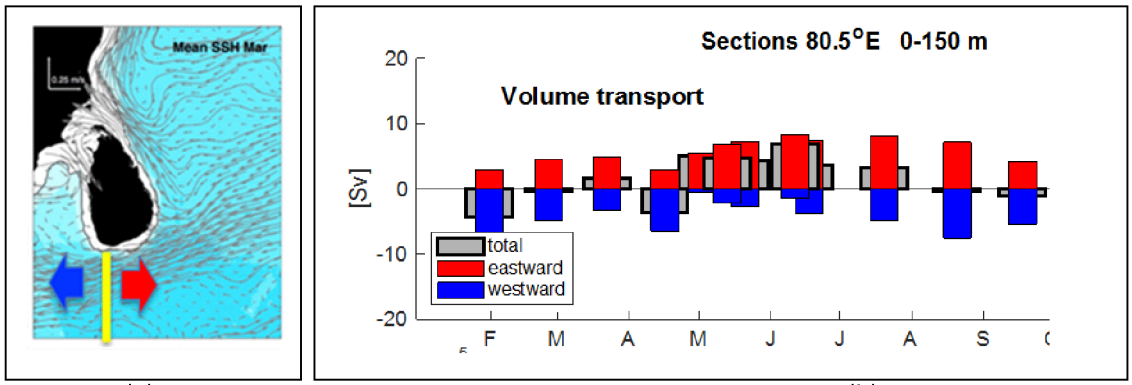


Fig. 2. (a) and (b) shows location map of the glider trajectory calculated volume transport during the period.

The volume transport calculated up to 150m depth. The diagram (a) indicates maximum net transport towards east during April to July. The net volume transport is about 5 Sv ($1x10^6$ m^3). The highest transport recorded in June that may be due to effect of south west monsoonal circulation in the Bay of Bengal.

Publications

Abstracts

1. ***S.U.P. Jinadasa***, Iossif Lozovatsky, P.N. Ranasinghe, H.J.S. Fernando (2017), Ocean Turbulence and Mixing around Sri Lanka, NARA scientific sessions, 27th July, NARA Auditorium, Colombo 15, Sri Lanka.

2. ***S.U.P. Jinadasa***, Iossif Lozovatsky, P.N. Ranasinghe, Jae-Hak Lee and H.J.S. Fernando (2017), Episode of High Frequency Internal waves in the East China Sea, SLAFAR annual sessions, 27th July, NARA Auditorium, Colombo 15, Sri Lanka.

3. Imalaka Nayanamali, ***S.U.P. Jinadasa*** and P.N Ranasinghe, (2017), Analysis of Sea Level Trends in the Indian Ocean by Means of Historical Records, SLAFAR annual sessions, 27th July, NARA Auditorium, Colombo 15, Sri Lanka.

4. ***Udaya Priyantha Jinadasa***, Craig Lee, Gayan Pathirana, Luca Centurioni, Verena Hormann, Hemantha Wijesekara and Harindra Fernando, (2017), Monsoon Impact on Circulation Pathways and Formation of Large Scale Eddies in the Indian Ocean, WESTPAC 2017 Conference, 17th – 19th April 2017, Qingdao, China.

5. ***Udaya Priyantha Jinadasa***, Iossif Lozovatsky, Jae-Hak Lee, Nalaka Ranasinghe, Harindra Fernando, (2017) Effects of Small Scale Dynamics on Ocean Boundary Layer in Shallow Waters with Special Reference on East China Sea and the Bay of Bengal, WESTPAC 2017 Conference, 17th – 19th April 2017, Qingdao, China.

6. H.B.U.G.M. Wimalasiri, ***S.U.P. Jinadasa***, D.C.T. Dissanayake. (2017), Bioluminescence in Puttalam Lagoon of Sri Lanka, NARA scientific sessions, 27th July, NARA Auditorium, Colombo 15, Sri Lanka.

7. H.B.U.G.M. Wimalasiri, ***S.U.P. Jinadasa***, D.C.T. Dissanayake. (2017), Variation in vertical distribution of bioluminescence intensity at a fixed location of the south coast of Sri Lanka during south-west and north-east monsoon, 23rd annual scientific session of the Sri Lanka Association for fisheries and Aquatic Resources, 26th May Mattakuliya Sri Lanka.

Full Papers

1. An Undercurrent off the East Coast of Sri Lanka, (2017), Arachaporn Anutaliya, Uwe Send, Julie L. McClean, Janet Sprintall, Luc Rainville, Craig Lee, ***S. U. Prinyatha Jinadasa***, Alan J. Wallcraft, and E. Joseph Metzger, *Journal of Ocean Science*

2. Lozovatsky, I, H.J.S. Fernando, Z. Liu, J.-H. Lee, ***S.U.P. Jinadasa***, J. Planella-Morato, (2017), On the Probability Distribution of Kinetic Energy Dissipation Rate in Ocean: Observations and Approximations, Journal of Geophysical Research-Oceans

International workshop/ Conferences

1. MoU signing ceremony for Monsoon Intra-seasonal Oscillation in the Bay of Bengal project initiatives

2. WESTPAC 10 International Scientific Conference, Qingdao, China from April 17-20, 2017

3. WESTPAC meeting Qingdao, China, from April 21-23, 2017

Award Received

Presidents Awards for Scientific Publications in 2017

PROJECT NO : 1.6.2

ASSESSMENT OF PHYTOPLANKTON WITH SPECIAL REFERENCE TO TOXIC DINOFLAGELLATES, OFF WEST COAST OF SRI LANKA

Responsible Officer : Dr. H.B. Jayasiri

Introduction

Phytoplankton stand on the base of the marine food chain thus affects higher trophic levels such as shellfish and fin fish population. Phytoplankton is a key component of marine ecosystems and act as a potential bio-indicator of water quality alterations in response to local and global impacts. Some species of phytoplankton can have harmful effects on organisms at different trophic levels. Blooms of some otherwise-harmless species result in massive fishkills by depleting dissolved oxygen or by clogging the gills of fish. Rapid cell division and population growth in phytoplankton can produce millions of cells per liter of seawater, resulting in visible blooms or "red tides." At least 90 of these cyst producing species are known to be harmful (Sournia 1995) and a minimum of 45 species are considered as toxic (Sournia 1995; Smayda 1997; Hallegraeff 2003). At certain times, the occurrence of a toxin-producing species of phytoplankton may affect wildlife, causing illness or death. Human consumers of certain seafood items (especially bivalve shellfish) are also at risk in the absence of adequate monitoring programs. This study provides the valuable information on phytoplankton community structure in coastal waters, off west-coast.

Objectives

- To evaluate spatial and seasonal patterns of abundance, diversity and composition of phytoplankton in relation to nutrients
- To identify and quantify the toxic dinoflagellates in coastal waters

Methodology

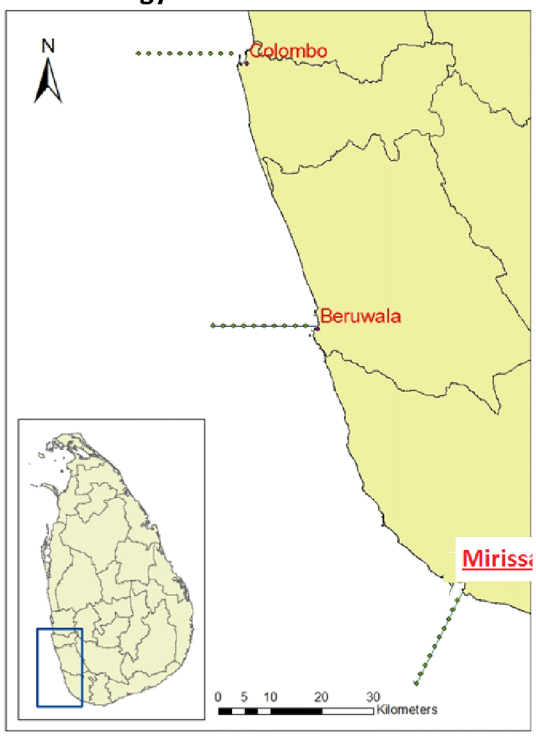


Fig. 1. Study area showing sampling sites and locations

Three sampling sites (Colombo, Beruwala, Galle) each containing 2 transects of 20 km were selected for sampling. Each transect consist of 10 sampling positions (Fig. 1). Field surveys were carried out quarterly except 3rd quarter during SW monsoon due to rough sea condition. To study the nutrient levels, water samples were collected at the depth of 0.5 m from the surface and analyzed by standard methods for Nitrate, Nitrite, Phosphate and Silicate (Grasshoff et al., 1999). Further, water samples were collected to analyse the chlorophyll-a (Parsons & Strickland, 1963). Phytoplankton sampling was carried out using a net with a mesh size of 10 µm. Phytoplankton samples were analyzed for density, diversity and species composition.

Results

Diatoms were dominated at all the three study sites and relative compositions at Colombo, Beruwala and Mirissa were 85, 94 and 97% respectively Dinoflagellates were comparatively high in Colombo (15%) than that of other sites (Fig. 1, 2 and 3). Phytoplankton abundance is generally high in Mirissa and Collombo than that of Beruwala (Table 1). In General, the phytoplankton abundance decreased towards the offshore. Total abundance is significantly higher in Beruwala than that of other two sites and varied from 129- 754 with a mean of 301 no/l. Total of 10 toxic sps. were reported during the study. Dinoflagellates and toxic species are significantly higher in Colombo than that of other sites and varied from 2-7 Nos with a mean of 4 species. Diatom species of *Chaetoceros* sp. (35%), *Trichodesmium* sp. (85%) and *Nitzschia* sp. (50 %) are dominated in Colombo, Beruwala and Mirissa respectively and indicate the possibility of blooms of these diatom species at particular sites.

The chlorophyll-a level was significantly higher in Colombo than that of other two sites. TSS level is significantly higher in Colombo than that of other sites while TSS level was intermediate at Mirissa. Nitrate-N was significantly higher in Colombo and Mirissa than that of Beruwala. Phosphate-P was significantly higher in Colombo than other sites while it was intermediate in Beruwala. Silicate-Si was significantly higher in Colombo than other sites (Table 2).

Table 1. Total abundance, dinoflagellate and toxic sps. abundance and number of toxic sps. at three sites

Site		Phytoplankton abundance (no/l)	Dinoflagellates abundance (no/l)	Toxic species abundance (no/l)	Number of toxic sps.
Colombo	Mean	808.43	55.99	21.10	*3.67*
	Range	(42.58-2030.86)	4.54-167.90	0.00-84.49	1-7
Beruwala	Mean	336.99	18.96	1.96	1.9
	Range	129.47-753.97	9.41-32.56	0.35-3.53	1-3
Mirissa	Mean	900.98	23.60	2.15	1.1
	Range	566.02-1518.47	10.40-44.72	0.00-4.89	0-2

Table 2. Reported toxic dinoflagellates

Alexandrium catenella

Alexandrium monilatum

Gymnodinium sanguineum

Protoperidinium depressum

Protoperidinium curtipes

Prorocentrum micans

Prorocentrum redfeildil

Dinophysis caudate

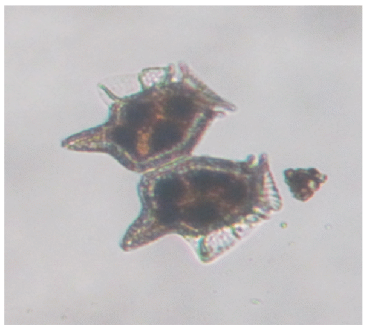
Noctiluca scintillans

Gymnodinium sp.

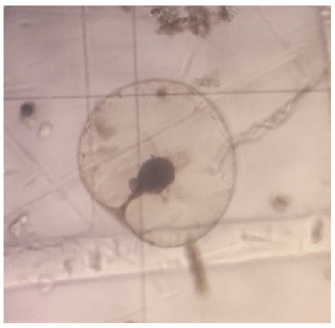
Reported toxic species



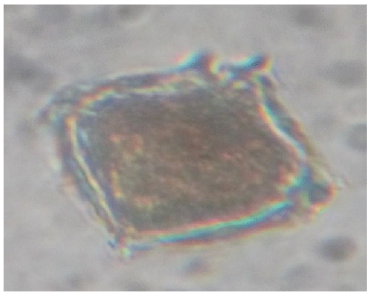
Prorocentrum sp.



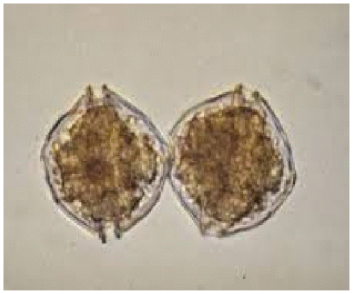
Dinophysis sp.



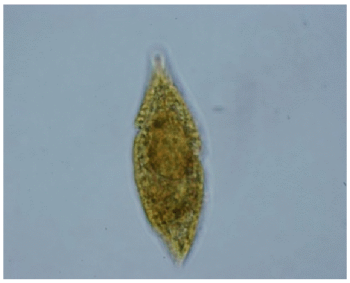
Noctiluca sp.



Protoperidinium sp.



Alexandrium sp.



Gymnodinium sp.

Table 2. The mean and range of dhlorophyll-a and nutrients at three sites

Site	Descriptive statistics	Chlorophyll-a (µg/l)	TSS (mg/l)	Nitrate-N	Phosphate-P (mg/l)	Silicate-Si (mg/l)
Colombo	Mean±SD	2.55±0.62	4.96±0.32	0.037±0.012	0.566±0.0018	0.740±0.014
	Range	0.79-5.50	3.4-6.1	0.001-0.083	0.561-0.574	0.686-0.806
Beruwala	Mean±SD	0.68±0.17	3.51±0.23	0.016±0.001	0.013±0.0012	0.124±0.064
	Range	0.10-1.65	2.2-4.7	0.013-0.022	0.008-0.022	0.042-0.697
Mirissa	Mean±SD	0.24±0.04	4.09±0.53	0.044±0.004	0.0082±0.0006	0.059±0.006
	Range	0.10-0.43	2.0-7.3	0.033-0.077	0.006-0.012	0.042-0.105

Table 3. Pearson's bivariate correlations of phytoplankton and bio-chemical parameters

		Dinoflagellates	Toxic sps.	Chl-a	TSS	NO_3^--N	PO_4^{3-}-P	SiO_4^{4-}-Si
Total abundance	r	0.78**	0.71**	0.60**	0.24	0.77**	0.16	0.14
	p	0.00	0.00	0.00	0.21	0.00	0.40	0.47
Dinoflagellates	r	1	0.97**	0.79**	0.20	0.44*	0.42*	0.39*
	p		0.00	0.00	0.31	0.02	0.02	0.03
Toxic sps.	r		1	0.79**	0.21	0.45*	0.46*	0.44*
	p			0.00	0.27	0.01	0.01	0.02
Chl-a	r			1	0.34	0.44*	0.69**	0.66**
	p				0.07	0.02	0.00	0.00
TSS	r				1	0.39*	0.38*	0.33
	p					0.04	0.04	0.08
NO_3^--N	r					1	0.14	0.10
	p						0.47	0.62
PO_4^{3-}-P	r						1	0.93**
	p							0.00
SiO_4^{4-}-Si	r							1
	p							

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

Total Phytoplankton abundance significantly correlated with dininoflagellates, toxic sps., chlorophyll-a and nitrate-N at p=0.01. Dinoflagellates significantly correlated with toxic sps., chlorophyll-a and nitrate-N at p=0.01. Toxic sps. significantly correlated with chlorophyll-a at p=0.01 and nitrate-N, phophate-P at p=0.05 (Table 3).

Publications

Proceedings

1. Weerakoon, A.P., **Jayasiri, H. B.**, Jayamanne, S.C., and Guruge K.P.G.K.P. (2017). Phytoplankton Abundance and Diversity in Three Sea Bathing Sites in Western and Southern Coasts of Sri Lanka. 5th International Symposium on Advances in Civil and Environmental Engineering Practises for Sustainable Development (ACEPS-2017). 16 March 2017, Faculty of Engineering, University of Ruhuna, Galle.

Abstracts

1. Y.P. Kumara and **H.B. Jayasiri** and G.W.A.R Fernando, 2017. Diversity and abundance of marine phytoplankton in relation to nutrients in southern Bay of Bengal, 17, October 2017. Third National Marine Symposium 2017, BMICH, Colombo.

2. Y.P. Kumara and **H.B. Jayasiri** and G.W.A.R Fernando, 2017. Diversity and abundance of marine plankton and hydrography in southern Bay of Bengal, 8-9, September 2017. Proceedings, PGIS Research Congress 2017.

3. Weerakoon, A.P., **Jayasiri, H. B.**, Jayamanne, S.C., and Guruge K.P.G.K.P., 2017. Variation of the abundance and composition of dinoflagellates in three sea bathing sites in the western and southern coasts of Sri Lanka, NARA Scientific Sessions, 27the July 2017. NARA auditorium, Colombo 15.

4. Y.P. Kumara and **H.B. Jayasiri**, 2017. Diversity abundance and biomass of marine zooplankton in relation to nutrients in southern Bay of Bengal, 27th July 2017. NARA auditorium, Colombo 15.

5. **H.B. Jayasiri**, S.U.P.Jinadasa, K.Arulanandan and D.D.D.Weragodatenna, 2017. Spatio-temporal variation of total suspended solids at surface waters of off Colombo, 27th July 2017. NARA auditorium, Colombo 15.

6. Y.P. Kumara' **H.B.Jayasiri**, Fernando, G.W.A.R. 2017. Diversity and abundance of marine phytoplankton in relation to nutrients in southern Bay of Bengal, Third National Marine Symposium, 17th October, 2017, BMICH, Colombo.

7. E.S. De Silva, K.H. Niroshana and **H.B. Jayasiri**, 2017. Determination of microplastic contamination in water biota with particular emphasis on fish and mussels: a case of southern coastal waters of Sri Lanka, 23rd Annual Scientific Sessions 2017, 26th May 2017 at NARA, Colombo 15

Book Chapters

1. Jayasiri, H.B. 2017. Book chapter on "Marine Debris: Problems and Solutions of the Changing Ocean" in Marine Pollution and Climate Change Ed.,Andres Hugo Arias andJorge Eduardo Marcovecchio (Print ISBN: 978-1-4822-9943-4 eBook ISBN: 978-1-4822-9944-1). CRC Press, Taylor & Francis Group Pages 136–165 (doi.org/10.1201/9781315119243-7)

International workshop

1. WESTPAC Training Workshop on Distribution, Source, Fate and Impacts of Marine Microplastics in Asia and the Pacific, 20–22 September 2017, Phuket, Thailand.

PROJECT NO: 1.6.3

QUALITATIVE AND QUALITATIVE ANALYSIS OF MICRO-PLASTIC DEBRIS IN SELECTED SITES OF WESTERN TO SOUTHERN COASTAL STRETCH IN SRI LANKA

Responsible Officers : Mr.W.R.W.M.A.P. Weerakoon

Mrs. T.B.D.T Samaranayake

Dr. H.B. Jayasiri

Highlights

The study addressed the morphological identification and quantification of plastics with an emphasis on micro-plastics in coastal sand and surface waters along the west and south west coasts during January to December 2017. The major objectives of the project were to study the plastic content in sea water and beach sediments whereas to quantify the plastic content in three selected sites, namely, Colombo, Beruwala and Hikkaduwa. Surface water samples and beach sand samples were collected and analyzed using a standard methodology introduced by the NOAA. Samples were subjected to laboratory tests, where several physical characteristics were identified.

Results revealed that the majority of plastics in both water and beach sand samples are micro-plastics. The results of *Fourier-transform infrared spectroscopy (FTIR)* conducted for surface water samples in Colombo disclosed that the vast majority of plastic particles found are micro-plastics in the range of 250 µm–1 mm, whereas the second most abundant category was micro-plastics in the range of 1-5 mm. At both off-shore and on land, the abundance of micro-plastics is significantly higher compared to other categories.

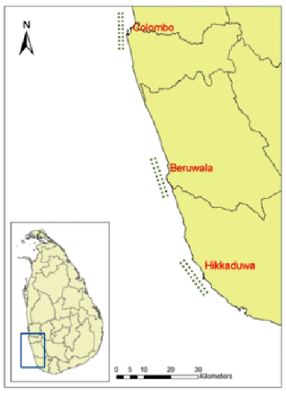
With regard to the western coast, the highest abundance of plastics in both off-shore and land were reported from Wellawaththa whilst the least pollution was recorded from Uswetakeiyawa. In the South-western coast, Beruwala on average is more polluted compared to Hikkaduwa.

The results disclose that there are spatial variations in the distribution of plastic particles where waters that are adjacent to fisheries harbors, both in Beruwala and Hikkaduwa contain considerably large number of plastic particles with a notable weight. Moreover, the statistics prove that popular beaches contain more plastic litter, compared to less popular sites, while waters adjacent to water channel openings contained more plastic particles. However, the study highlights that the majority of countable micro-plastic, especially in the nano-range are not weighable. Thus the most accurate measure about micro-plastics is the number of particles per unit volume.

Narration of the study

Methodology

Seven sites from Colombo (from Uswetakeiyawa to Wellawaththa), 15 sites from Beruwala (from Maggona to Induruwa) and 14 sites from Hikkaduwa (from Seenigama to Dodandoowa) were selected for the study (Figure 1), focusing on beaches, river mouths, water out-flows, infrastructure, *i.e.* Hotels and residences. Both surface water and beach sand sampling were done where surface water was sampled from locations of 2-3 transects, as triplicates using a *"Manta net"* (mesh size of 300 µm). Beach sand was sampled from locations in between the high tide line and the rack-line. A standard methodology introduced by NOAA was used for the analysis.



Results

Plastics in Surface Water

The mean abundance of micro-plastics in surface water, Colombo, Beruwala and Hikkaduwa were 0.2896, 0.2041 and 0.1502 particles per m^2 respectively (Figure 2).

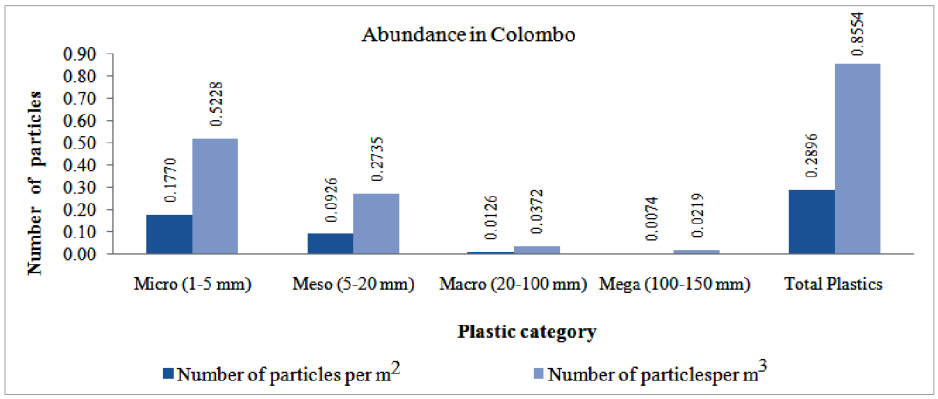


Fig. 2 (a). Abundance of plastics in Colombo

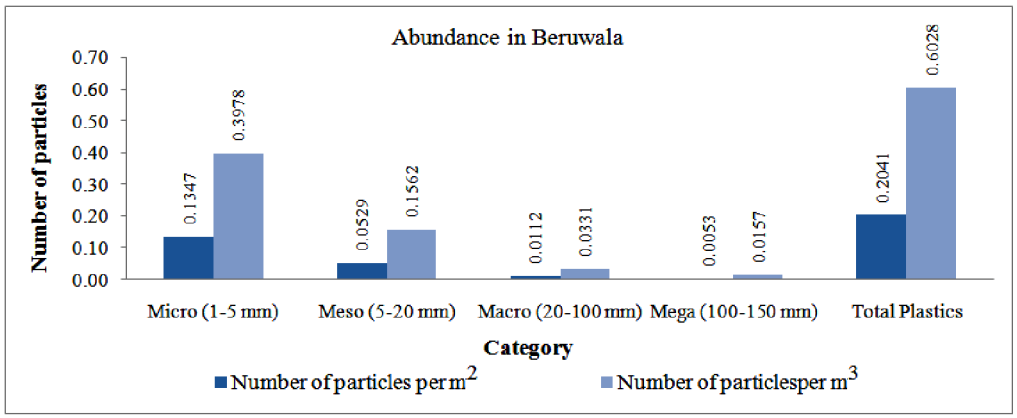


Fig. 2 (b). Abundance of plastics in Beruwala

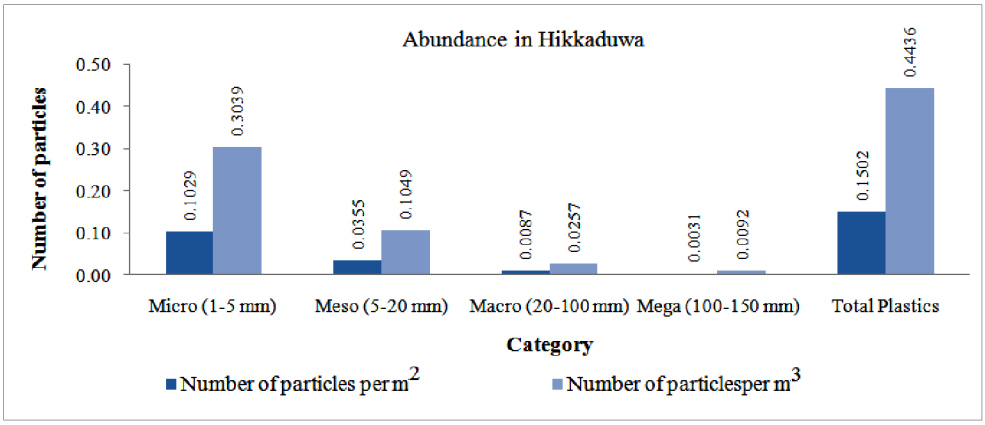


Fig. 2 (c). Abundance of plastic in Hikkaduwa

In all locations, micro-plastics were the major category of plastics, in terms of number of particles. The level of plastic pollution in Colombo was large, compared to Beruwala and Hikkaduwa. The average (monthly) weight of micro-particles (1-5 mm category) in surface water in off-Colombo, Beruwala and Hikkaduwa were 0.1138, 0.0994 and 0.0863 grams per m^2 respectively and were considerably low, compared to the number of particles recorded. The total monthly mean of plastics found on waters in Colombo, Beruwala and Hikkaduwa were 1.5504, 1.1609 and 0.7969 grams per m^2 respectively (Table 1).

Table 1. Weight of Plastic Particles (Average monthly mean)

Category	Micro-plastics (1-5 mm)	Meso-plastics (5-20 mm)	Macro-plastics (20-100 mm)	Mega-plastics (100-150 mm)	Total Plastics
Colombo g/m^2	0.1138	0.0757	0.0404	1.3205	1.5504
Colombo g/m^3	0.3362	0.2235	0.1194	3.9002	4.5792
Beruwala g/m^2	0.0994	0.0621	0.0508	0.9486	1.1609
Beruwala g/m^3	0.2936	0.1834	0.1500	2.8018	3.4288
Hikkaduwa g/m^2	0.0863	0.0572	0.0389	0.6145	0.7969
Hikkaduwa g/m^3	0.2549	0.1689	0.1149	1.8150	2.3537

Furthermore, the abundance of micro-plastics was significantly high in Wellawaththa (77.45 particles per m^2; 229.25 particles per m^3, including the 250 µm – 1 mm category) compared to other sites. The lowest abundance of plastics was recorded from Uswetakeiyawa with 25.85 particles per m^2 and 76.52 particles per m^3.

The abundance of plastics at off-shore adjacent to the fisheries harbor, Beruwala (0.3753 particles per m^2; 2.2203 grams per m^2), and *'Aluth-wewa'* stream (0.2718 particles per m^2; 1.6029 grams per m^2) were higher than other locations (average monthly abundance; 0.2041 particles per m^2, 1.1609 grams per m^2). Moreover, the abundance of plastics at off-shore adjacent to Hikkaduwa fisheries harbor (0.1868 particles per m^2, 0.8878 grams per m^2), fish market (0.1811 particles per m^2, 0.7204 grams per m^2), Dodanduwa water-out flow (0.1864 particles per m^2, 0.9462 grams per m^2) and Dodanduwa fisheries harbor (0.1821 particles per m^2, 1.0559 grams per m^2) were greater than the average abundance of 0.0031 particles per m^2 and 0.6145 grams per m^2.

Micro-plastics in Beach Sand

The overall mean abundance of plastics found in beach sand at the locations of Colombo, Beruwala and Hikkaduwa were 396,110, 293,603, and 186,205 particles per m^3, with average weights of 0.5324, 0.3038 and 0.3439 kg per m^3 respectively. Accordingly, the results reveal that beach sand in Colombo is largely polluted with plastics, compared to that in Beruwala, and Hikkaduwa (the least polluted).

Table 2. Abundance of plastics in beach sand

Coast	No. of particles/ m^3	Weight kg/ m^3
Colombo	396,110	0.5324
Beruwala	293,603	0.3038
Hikkaduwa	186,205	0.3439

The major category of plastics found in sand samples in all sites was micro-plastics. The distribution is similar to that of water samples, except the number of Meso-plastics was higher in Beruwala (Figure 3).

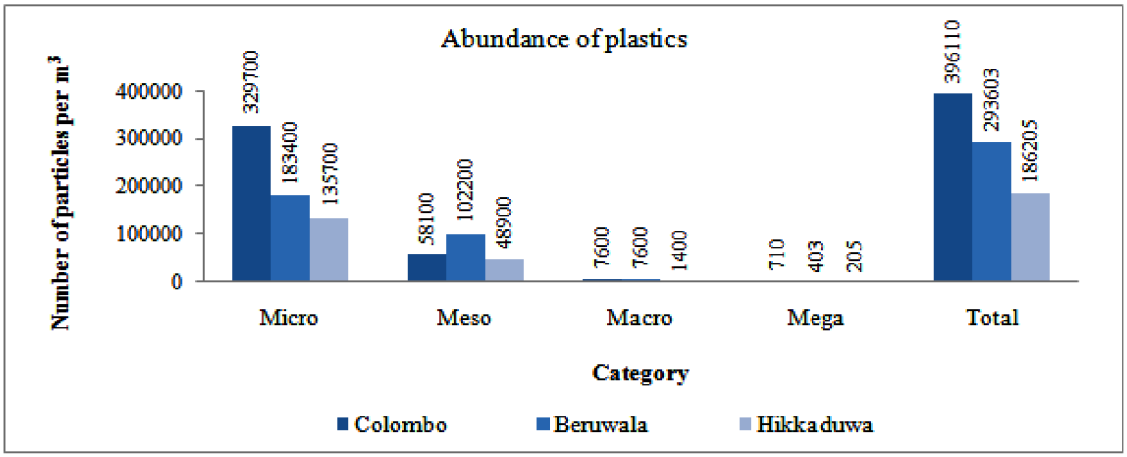


Fig. 3 (a). Abundance of plastics in terms of number of particles per m^3

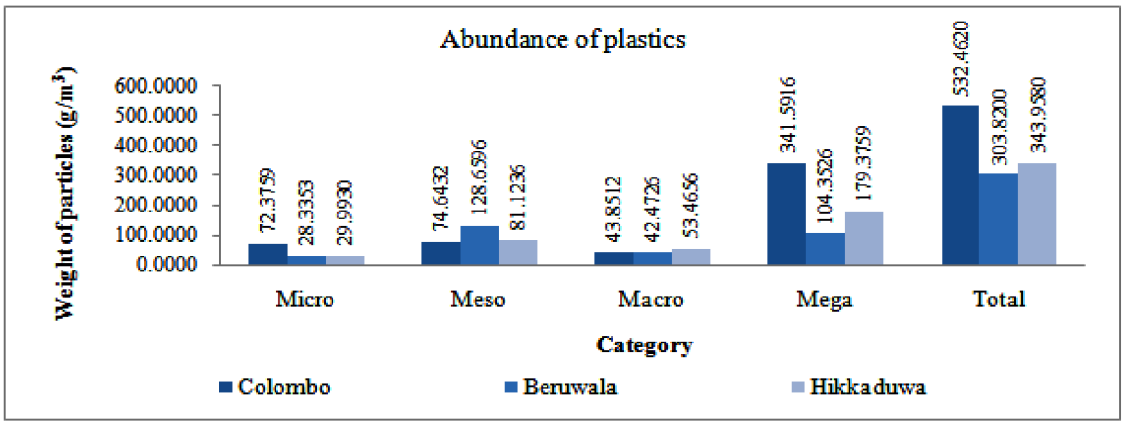


Fig. 3 (a). Abundance of plastics in terms of weight of particles (grams) per

Table 4 illustrates the relative position of Sri Lanka, among a few locations in the world that has been assessed for micro-plastics. Although, analysis of micro-plastics is a novel topic, and findings are limited yet, the available data below reveal that the micro-plastic contamination around Sri Lanka is lesser compared to some parts of the world.

Table 4. Level of micro-plastic pollution in Sri Lanka – A comparison

Area	No. of particles / m^3
Northwest Atlantic	67
Southern California	8
Northeast Atlantic	2.46
Southern San Francisco Bay	2.0
Sri Lanka (Colombo)	0.85*
Sri Lanka (Beruwala)	0.60*
Sri Lanka (Hikkaduwa)	0.44*
Western Mediterranean (Central)	0.15

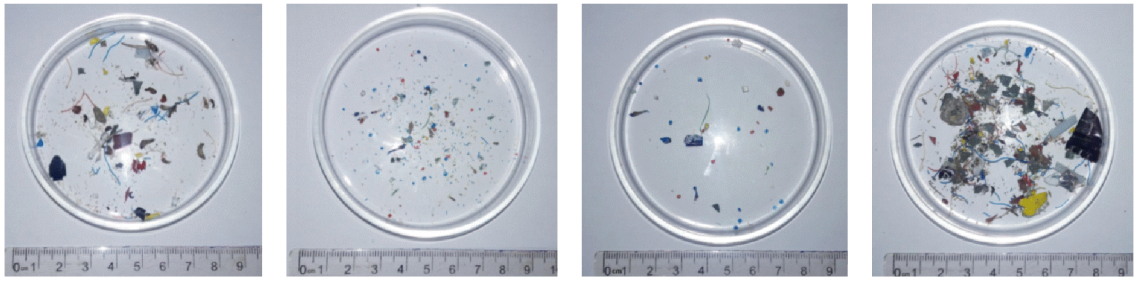
*Note: *Excluding the 250 µm – 1 mm category*

Sources: Takada,2006; Ogata et al. 2009: "International Pellet Watch" Sutton et al (2016). "Marine Pollution Bulletin", www.elsevier.com

Visual Examination, Identification and Classification of Plastics

The visually identified plastic particles including micro-plastics (Figure 4) were confirmed by a *'hot-needle' test* and were further categorized as filaments, films and fragments. Results showed a significant difference in categories of micro-plastics. In all sites, over 40% of the particles were filament-shaped micro-plastics. The abundance in terms of numbers of 'filament type' micro-plastics were notably higher in Wellawatte (56.37 items per m^3, including the particles in the range of 250

µm–1 mm), compared to other sites in Colombo. Furthermore, this type was prominent in sites adjacent to fisheries harbors, both in Beruwala and Hikkaduwa. The categories were further accessed via microscopy imaging (Figure 5).



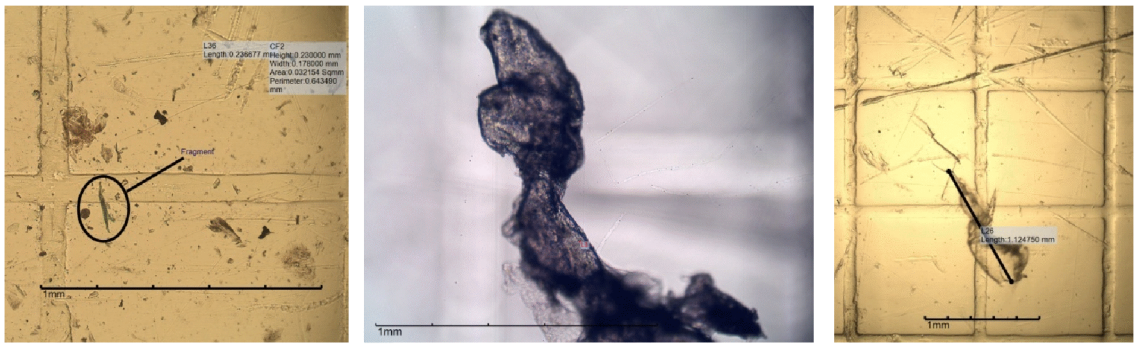


Figure 4: Manual Separation of plastics

Figure 5: Microscopic images of micro-plastics

Conclusions

In line with the findings, it is concluded that all three locations surveyed have been contaminated with plastics, where micro-plastics are the major category among all plastic categories.

Popular beaches are more polluted compared to relatively less popular beaches. Furthermore, sites adjacent to boat landing sites and harbors were considerably polluted compared to others. Colombo was the most polluted site with plastics whereas Hikkaduwa was the lease polluted site. In Colombo, Wellawatte was more polluted compared to other sites, and Uswetakeiyawa is least polluted.

Notably, the waters that are adjacent to fisheries harbors, both in Beruwala and Hikkaduwa contain considerably large number of plastic particles with notable weight. Moreover, the statistics prove that popular beaches contain more litter, compared to less popular sites, while waters adjacent to channel openings (*i.e. 'Munasinghegoda' stream* and *'Athuruwella' stream* in Beruwala) contained more plastic particles.

Limitations

Due to the unavailability of resources, Fourier-transform infrared spectroscopy (FTIR) was not conducted for the samples collected from Beruwala and Hikkaduwa. Those samples are preserved, and will be assessed in the future.

Even though the Manta-trawler is the most suitable device for surface water sampling, plankton net with a similar mesh size was used due to the unavailability of the recommended sampling device.

Recommendations

- The policy makers may pay attention to waste disposal at and closer to fisheries harbours and fish markets whereas on waste disposal by residents or industries located nearby water channels /out flows.

- Pollution control in Colombo, is crucial since it has a significantly large and harmful amount of plastic litter accumulated compared to Beruwala and Hikkaduwa.

- Assessing industrial and residential water discharge is suggested to further research on nano-level micro-plastic particles such as mirco-beads. For example, tests for micro-beads shall be checked from the water discharged from hotels and residents closer to the coastline.

- Even though, the litter is generated mostly from land based sources, those can be distributed by ocean currents. Thus, further research shall be focused on assessing movements of plastic particles with regard to ocean currents

- A notable number of plastic-particles, especially in the micro-range is found in Hikkaduwa coral reefs. Although illegal dumping or discharge of pollutants is restricted, pollution due to passive movements must be assessed since micro-plastics can be detrimental to the coral based eco-system.

- Moreover, it is important that the awareness of the society is re-checked and ecology-concerned population is build. Thus, awareness and disseminating knowledge is equally essential and recommended.

- Chemical and physical properties of micro-plastics may be further assessed since those properties may contribute plastic particles to move differently in diverse sea conditions. For instance, plastics made of different matter may move in water due to the changes in salinity, water temperature, wave actions and turbulence etc. Accordingly, many micro-plastic particles may reside below the surface or in the sea bed as sediments. Thus, researching on below-surface plastics and sediments is recommended.

Publications

1. A.M.G.A.D. Athawuda, H.B.Jayasiri, S.C. Jayamanne, W.R.W.M.A.P. Weerakoon, K.P.G.K.P. Guruge, and G.N.N. Thushari (2017). Micro-plastic contamination in surface water of west coast, off Colombo, Sri Lanka. In proceedings of the 2nd International Conference on Oceanography of the Bay of Bengal, 2018.

2. A.M.G.A.D. Athawuda, H.B.Jayasiri, W.R.W.M.A.P. Weerakoon S.C. Jayamanne, K.P.G.K.P. Guruge, and G.N.N. Thushari (2017). Quantitative Estimation of the Abundance of Micro-plastics in surface water, off Colombo, Western Coast of Sri Lanka. In proceedings of the International Research Symposium (IRS-UWU), 2018, Uwa Wellassa University of Sri Lanka.

PROJECT NO : 4.2.2

INTEGRATED EFFORT ON HABITAT MAPPING AROUND SRI LANKA (VANKALEI REEF)

Responsible Officers : Mr. S.U.P Jinadasa

Mr. Akila Harishchandra

Mr.Sudheera Gunasekara

Introduction

Remote sensing enables the simultaneous study of extensive reef areas for the assessment of spatial patterns and can provide a high frequency of observation for the assessment of temporal patterns. Habitat mapping is often created with optical passive remote sensing, integrated with field data for calibration and validation.

Study area

Vankalai, Arippu, Silavathurai reefs are important coral reefs located in Mannar. The distance from land area to reef area approximately 7.6 km, 6.75 km and 2 km for Vankalai, Arippu and Silavathurai reef gradually. Around Vankalai reef area depth is varied approximately from 1.2 m to 3.7 m, Arippu area from 3.7 m to 4.6 m and from 1.8 m to 4.6 m of Silavathurai reef.

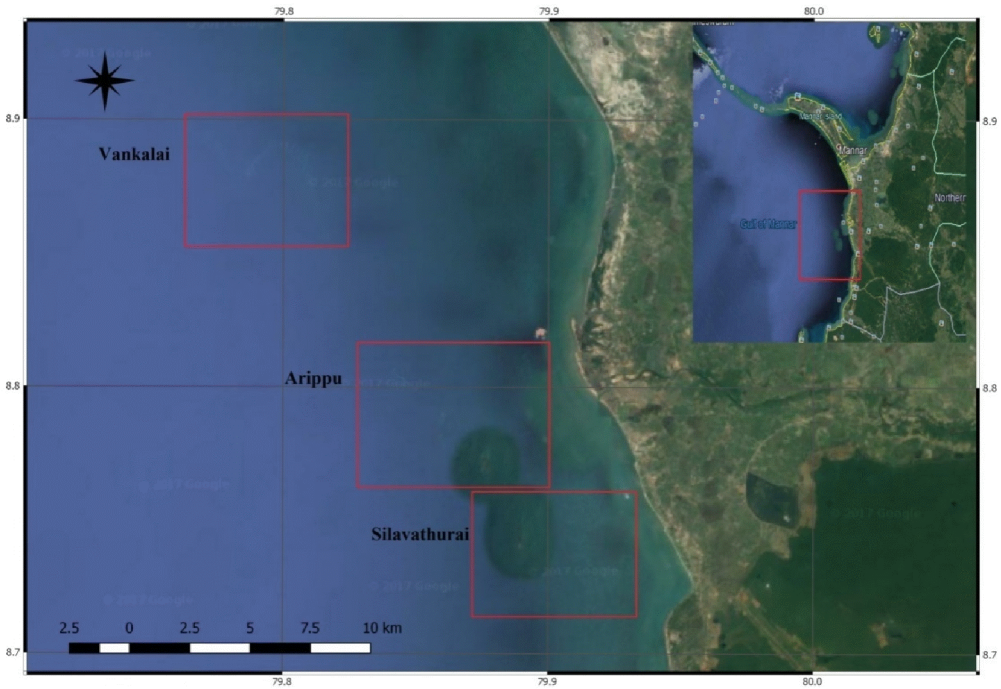


Figure 1: Coral reefs distribution in Mannar area

Materials and Methods

Materials

The Landsat series of sensors have been used for data acquisition on coral reefs since 1984, and therefore have the advantage of a long-time series archive. Landsat 8 has been used to produce a comprehensive inventory of reef structures around the globe. The Sentinel 2 MSI sensor provides similar data to Landsat 8, but a spatial resolution of 10 m in some bands may offer improved capability for coral reefs (Hedley *et al*., 2012). In particular, Landsat 8 and Sentinel 2 data is freely available.

Landsat 8 and Sentinel-2 MSI multispectral images were downloaded using USGS earth explorer (https://earthexplorer.usgs.gov/).

Data processing

Atmospheric correction was done by Dark object subtraction (DOS) method. Modified normalized difference water index was used to enhance open water features and to extract the accurate information of the object features from multispectral image. Mapping submerged habitat environment is confounded by the light attenuation. Hence the effect of variable depths of spectral signature was corrected by using depth invariant index (DII). For that individual band files and also water only image was created as an input raster layer for Landsat 8 and Sentinel-2 multispectral image for calculate the DII. Unsupervised classification was done using SCP tool under minimum distance classification algorithm.

QGIS, SNAP, SCP, R was used for data processing and analysis.

Collections of field data

A field visit was conducted on November 27th of 2017 to obtain required ground truth data. Due to the effect of adverse weather condition caused to prevent the data collection.

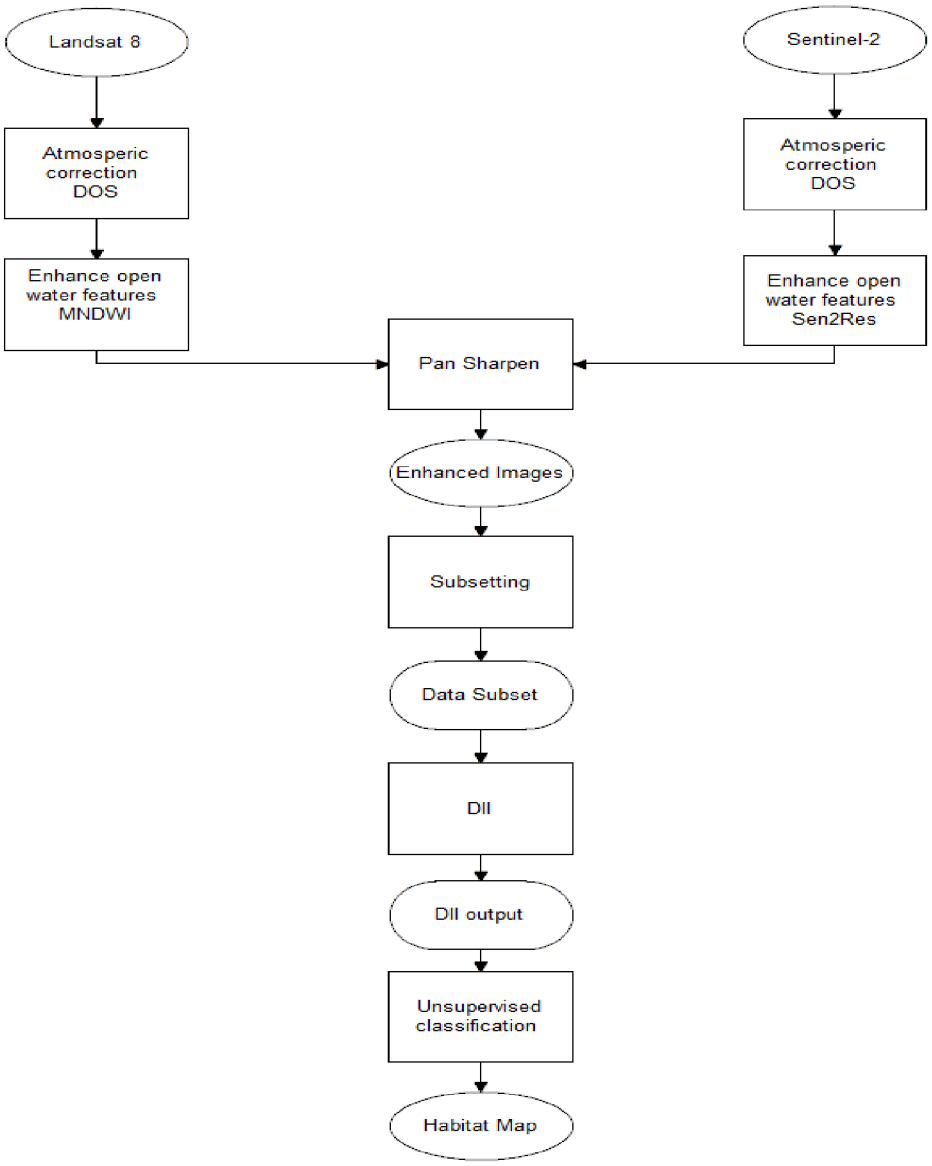


Figure 2: Flowchart of the methodology

Results

Habitat maps were generated using unsupervised classification are shown in figure 3, 4 and 5.

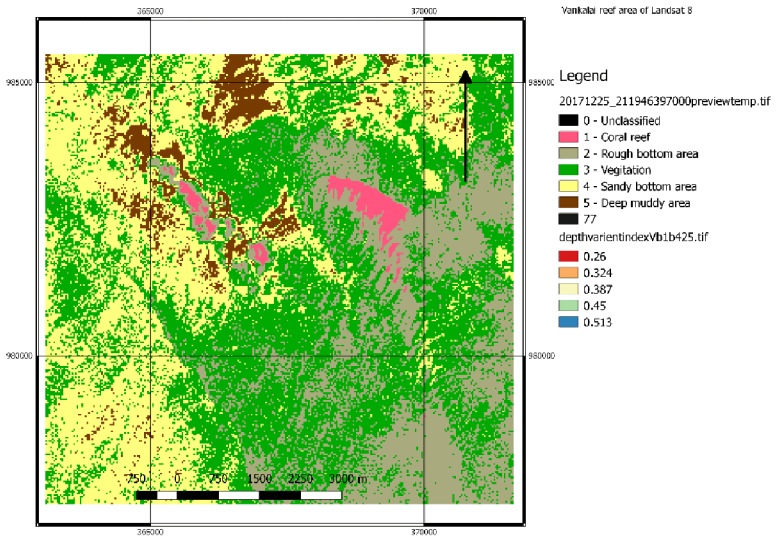


Figure 3.13: Vankalai reef area of Landsast 8 image.

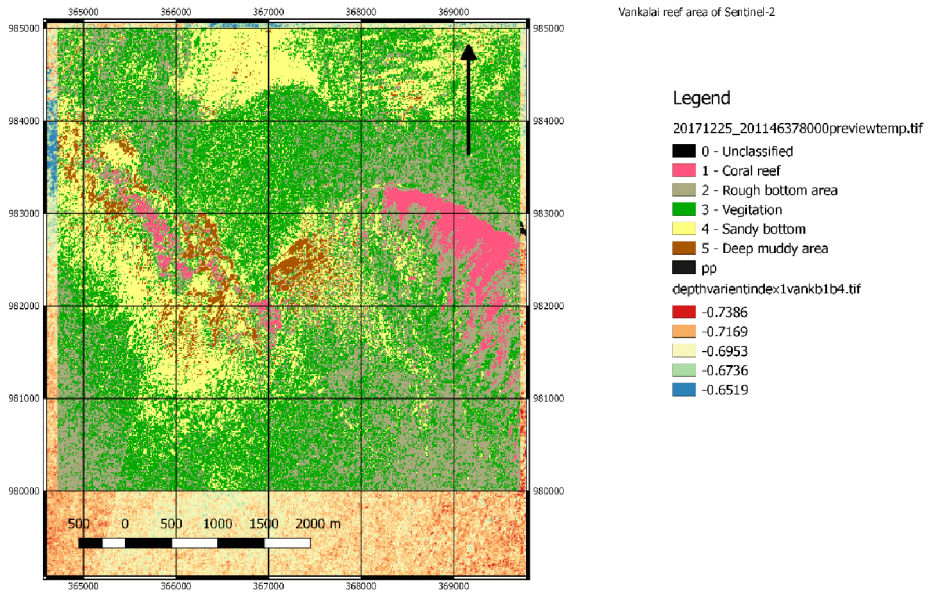


Figure 3.16: Vankalai reef area of Sentinel-2 image.

Discussion

Remote sensing techniques can be used successfully to habitat mapping in sub merged environment.

Limitations

Sri Lanka is located in ITCZ where cloud cover is typically high during throughout of the year. Therefore, obtaining cloud free satellite imagery is challenging task with 16 days of revisiting time of Landsat 8 and 10 days of revisiting time of Sentinel-2. Even though Landsat-8 data are available since 2013, only 3 images were clear enough for this study. Sentinel-2 has higher advantage with its' duel satellite system enables 5 days of revisit time when compare with Landsat 8. For future studies, Sentinel-2 has high probability of cloud free images.

Field data collection for ground truth was not success due to unfavorable weather. Lack of field data and bathymetry was major limitation of the study. Supervised classification of habitats and accuracy assessment was failed due to lack of field data.

Recommendations

Landsat 8 and Sentinel-2 data are free and methods are widely available. Free and open source software like SNAP, R, QGIS are capable of analyzing satellite data. New tool boxes (Sen2Res, Sen2Core etc. in SNAP), plugins (SCP in QGIS) and libraries (landsat in R) are sophisticated and highly capable when compare with commercial software such as ENVI, ERDAS Imagine or ArcGIS. Therefore, it is highly recommended use free and opensource data and software for habitat mapping. As well as must be conduct proper field survey to obtain ground truth data and continue this study for all reef areas of Sri Lanka.

Concussions

The availability of new-generation multispectral sensors on Landsat 8 and Sentinel-2 satellite platforms offers great opportunities to expand the environment study. Landsat 8 and Sentinel-2 was used for the study about coral reefs.

References

Hedley, J., Roelfsema, C., Koetz, B. and Phinn, S., 2012. Capability of the Sentinel 2 mission for tropical coral reef mapping and coral bleaching detection. *Remote Sensing of Environment*, *120*, pp.145-155.

PROJECT NO : 5.8
SRI LANKA OCEANOGRAPHIC DATABASE - INTEGRATION OF OCEAN DATA AND INFORMATION (1996-2000)

Responsible Officer : K. Arulananthan

Introduction

Oceanographic data are obtained by diverse means; instruments are lowered from ships, set adrift, or moored on cables and platforms and satellites scan the oceans from space. These data come in many different forms, from a single variable measured at a single point to multivariate, four-dimensional collections of data. These data are often irreplaceable and are always unique. Marine data can also be extremely expensive to collect.

Oceanography Division of National Aquatic Resources Research and Development Agency during its existence of 35 years, have been gathering a wide variety of oceanographic parameters, however there is no single point of access for the data. Unless these data are immediately collated, and if required restored and archived at a repository, the data could be loss permanently.

The project is initiated to develop capacity to create a dynamic oceanographic data repository, so that oceanographic data and information are made available to the users, including researchers and academic.

Activities

Sea level data from Trincomalee and Colombo sea level station are retrieved, quality control (Verify the quality of the data - using agreed standards), inventorized and the data is archived.

Data from the Mirrissa sea level station is retrieved and quality controlling of water temperature, water level, air temperature, relative humidity, air pressure and precipitation are completed and the data are inventorised and archived.

Mr. K. W. Indika and Ms. G.D.P. Niroshani, were trained on database management of hydrological and meteorological station, held in Qingdao, China during May 14-18, 2017.

Conclusion

Recent data sea level and meteorological data are being inventorised and archived, the data would be made available for public access, once the a data server is procured.

Though, two staffs were trained on data base management, they do not have sufficient background knowledge on quality control of data and database mangement. Recruiting two development officers, with technical background and assigning them exclusively to handle database management would facilitate successful conductance of the project.

Institute of Post Harvest Technology







5.7 INSTITUTE OF POST HARVEST TECHNOLOGY

Head of the Division: Dr. G. J. Ganegama Arachchi

Strategy: Development of post harvest technologies and make improvements in food safety measures

Eight Scientists comprising two Principal Scientists, two Senior Scientists and four Scientists are attached to IPHT. IPHT has conducted four research projects under thrust areas of reduction of post-harvest losses and value addition of aquatic resources including fisheries and seaweeds. Other additional community development projects were conducted using funds separately provided by MFAR. In addition, IPHT has provided Testing Services; consultancies; and tailor made training programs and awareness programs on reduction of fish quality losses, economic processing technologies and nutrition for industry and stakeholders including fishers, fish processors, fish sellers, school children in Sri Lanka.

PROJECT NO : 3.1.1
ASSESSMENT OF QUALITY DEPRECIATION OF FISH IN MULTI-DAY BOATS AND CENTRAL FISH MARKET

Responsible Officers : Dr. Geevika Ganegama Arachchi
Mrs. Pavithra Ginigaddarage,
Ms. Thushini Hemachandra,
Mr. Thiruchenduran
Ms. Achini Subashi

Introduction

The main objectives of this study were to assess current (in 2017) fish quality loss in MDBs compared to high level of fish quality loses reported as high as about 40% (weight basis) in the past years and introduction of designs for fish hold and mechanical refrigeration systems usable in MDBs to reduce high ice melting rates in present MDBs. This study scientifically investigated current level of fish post harvest quality losses of multi-day boats (MDBs) landed in selected fishery harbours as to represent all fishery harbours. The harbours selected were Kalpitiya, Negombo, Dickowita, Beruwala, Mirrissa, Puranawella, Dondra and Trincomalee. Present project investigated fish post harvest quality losses by survey (questionnaire, interview, and imaging); sensory based on-site evaluation of fish quality at harbours and microbiological and biochemical quality of Yellowfin tuna harvested targeting export market; fish washing water and ice at harbours and ice plants; and fish contact surfaces in boats. Sensory evaluation based post harvest quality losses of skipjack tuna which was landed from MDBs and intended for local fish consumption, were also assessed. The main purpose of this project was to suggest remedial measures required to reduce high fish quality losses in local MDBs to a low level, at least, for about 20% (weight basis).

This project also investigated quality changes of fish sold at retail level in Central Fish Market (CFM) at Peliyagoda as a continued monitoring task to verify if acceptable quality and safe fish is available for consumers and suggest improvements required in handling of fish at CFM.

Fishery Harbour	Fish Species	Average PHQL/%		Fishing Trip Duration (Days)						# of Boats according to the length	
				0-10	11-20	21-25	26-30	30-35	>35	<40'	≥40'
Beruwala	Skipjack tuna	28±13.8	MDBs #	5	21	6	7	2	4	26	19
			PHQL (%)	19.3	25.45	21.91	28.27	47.3	34.3		
Negambo	Skipjack tuna	17.1±14.4	#	15	15	2	2		6	28	12
			PHQL (%)	15.07	18.99	0	38		22.7		
Mirissa	Skipjack tuna	32.2±15.0	#	2	8	1	1	1		5	8
			PHQL (%)	10	35.9	30	50	33.3			
Dandora	Skipjack tuna	30.3±6.3	#	2	2					3	1
			PHQL (%)	30.7	24.9						
Puranawella	Skipjack tuna	39.3±9.9	#	2	5	2				6	3
			PHQL (%)	44.8	36.88	46.05					
Trincomalee	Yellowfin tuna	9.7±12.7	#	2	3						2
			PHQL (%)	2.15	9.6						
Kalpitiya	Yellowfin tuna	32	#	26	33	33				43	8
			PHQL (%)	27	34	8	-	1	-		

Results:

Fishery harbour	Post harvest quality of Export oriented yellowfin tuna in July- August , 2017
Dikkowita	MDBs=17 Export Quantity : 63.20% (Wt/Wt)

PHQL –Sensory evaluation based post harvest quality losses

MDB Multi-day boats

Investigation of sources of microbial contamination of fish in selected fishery harbours

In this study sources of microbial contaminations of fish were investigated in Beruwala, Negombo and Dikkowita fishery harbours. In addition to these, few samples of ice and harbor basin water samples of Kalpitiya area were also analyed. Results obtained are as follows.

Tap/well water (n= 16), harbor basin water (n = 17), Bilge water (n= 23), Ice from factories (n=25), used ice from boats (n=20), swabs from deck of boats (n=30) and swabs from fish holds of boats (n=30) were analysed as contamination sources for faecal coliforms, *E.coli*, *Salmonella* and *Listeria monocytogenes*.

Beruwala Fishery Harbour

	Faecal coliforms MPN/100ml	***E.coli* MPN/100ml**	***Salmonella***	***Listeria* spp.**
Tap water/well water (n=5)	80 - 1800+	35 - 250	Absent	Absent
Harbour basin water (n=5)	350 - 55000	55-25000	Absent	Absent
Bilge water (n=10)	3500 - 180000+	450 - 180000+	30% present	Absent
Factory Ice (n=5)	13 - 1800+	13 - 1800+	Absent	20% present
Ice from boat (n=10)	550- 160000	10- 160000	10% present	Absent
Swab deck of the boat (n=10)	70 - 1800 +	17 - 1800+	Absent	Absent
Swab fish hold of the boat (n=10)	7 - 1800+	3 - 1600	Absent	10% Present

Negombo Fishery Harbour

	Faecal coliforms MPN/100ml	***E.coli* MPN/100ml**	***Salmonella***	***Listeria* spp.**
Tap water (n=5)	2 to11	2 to11	Absent	Absent
Harbour basin water (n=5)	50 - 55000	25 - 25000	Absent	40% Present
Bilge water (n=08)	30 - 90000	13 - 90000	12% present	62%
Factory Ice (n=5)	80 - 1800+	13 - 1600	20%	20%
Ice from boat (n=10)	130 - 180000	25 - 180000	20%	40%
Swab deck of the boat (n=10)	25 - 1800+	5 - 1800+	20%	10%
Swab fish hold of the boat (n=10)	2 - 1800+	2 - 1800+	20%	30%

Dikkowita Fishery Harbour				
	Faecal coliforms MPN/100ml	**E.coli MPN/100ml**	***Salmonella***	***Listeria spp.***
Tap water/Municipal supply (n=5)	Absent	Absent	Absent	Absent
Harbour basin water (n=5)	225 - 1600	20 - 350	20%	Absent
Bilge water (n=05)	130 - 1800 +	13 - 1800+	Absent	Absent
Factory Ice (n=10)	11 - 1800+	ND - 1800+	10%	20%
Swab deck of the boat (n=10)	2- 1800+	ND - 350	10%	Absent
Swab fish hold of the boat (n=10)	ND - 1600	ND-225	Absent	Absent

Kalpitiya Fishery Harbour				
	Faecal coliforms MPN/100ml	**E.coli MPN/100ml**	***Salmonella***	***Listeria spp.***
factory ice (n=5)	35 - 350	35 - 130	absent	absent
harbour basin water (n = 2)	17 - 225	5 - 140	50%	absent
tap water	17	2	absent	absent

According to above results it can be seen that majority of the samples are heavily contaminated with feacal coliforms and *E.coli* except for one factory ice sample having no *E.coli*. detected. All the harbor basin water samples were heavily contaminated with *E.coli*. 20% (2/10) of harbour water of Dikkowita fishery harbor was detected with *Salmonella* spp. out of two samples from Kalpitiya fishery harbor one sample was detected with *Salmonella*. Since almost all the boats and captured fish are washed using harbor basin water, contaminations with pathogenic bacteria will lead to contaminate fish. Bilge water of Beruwala and Negombo fishery harbours contained Salmonella 30 % and 12% respectively. 20 % of the ice samples obtained from factories which supply ice to Negombo and Dikkowita fishery harbours contained *Salmonella*.

From above results it can also see that ice, boat decks and fish holds are also highly contaminated with feacal origin bacteria and some percentages with pathogenic bacteria. These can lead to contaminate fish. Therefore, this study shows that ice, water and fish contacting surfaces such as boat decks and fish holds can cause contaminations in fish. Therefore, it can be suggested that clean water and ice should be supplied to fishing boats and at unloading sites. Cleaning of boat surfaces/ fish contacting surfaces should also be done effectively to reduce the microbial load.

Microbial quality of yellowfin tuna (*Thunnus albacares*) landed at Dikkowita fishery harbour in Sri Lanka by multi-day boats

Dikkowita fishery harbour in Sri Lanka provides large amount of yellowfin tuna (*Thunnus albacares*) for export market. For that, they should be strictly in compliance with microbial standards. Aim of the present study is, therefore, to evaluate microbial quality of yellowfin tuna landed at Dikkowita fishery harbour by multi-day boats. During the study period of 10 weeks, one boat was randomly selected in weekly interval and 3 surface swab samples were collected from randomly selected 3 yellowfin tuna to test for faecal coliforms, *E. coli*, *Salmonella* species and *Listeria monocytogenes* . Results indicated that fish surface contained faecal coliform counts ranged from 0.02 (MPN)/cm^2 to 20.33 MPN/cm^2, *E. coli* counts ranged from 0.02 MPN/cm^2 to 20.33 MPN/cm^2. Two multi-day boats reported with *E. coli* counts of yellowfin tuna more 11 MPN/cm^2. One boat reported with *Salmonella* contaminated yellowfin tuna. *Listeria monocytogenes* contaminated yellowfin tuna were not reported from any boat. Thus, it can be concluded that yellowfin tuna landed at Dikkowita fishery harbour by multi-day boats during the study period were contaminated with faecal origin bacteria and pathogenic bacteria; hence it is necessary to reduce the microbial load of fish before processing for raw consumption.

Summary on cost estimates for installation of proposed mechanical refrigeration system suitable for boats that are in different length categories

• Technology has developed to improve fish chilling facilities in existing multiday boats

Boat Size Range	Specified Fish hold volume (m^3)for estimation of the cost	Fish storing Capacity fish to ice in ratio of 1:1.5 (kg)	System Installed/Fish storing temperature (^{0}C)	Compressor capacity (kW)	Investment cost for refrigeration system without tax (Rs)	Additional Operation cost on refrigeration system with fish stored with ice per trip (Rs)	Operation cost on refrigeration system per trip (ice + refrigeration) (Rs)	Payback period refrigerant plant with ice (years)
34-45 feet	$12m^3$	6000*	RSW tank: (-1) – 0	0.57	1,087,000	41,040		0.6
34-45 feet	$10m^3$	3000	Ref. Fish hold – 0.5 – 2	0.6	1,291,000	32,832	62,832	1.3
34-45 feet	Fish hold: $10m^3$ Bait hold: $5m^3$ Slurry tank: $6m^3$	3000	Ref. Fish hold: 0.5 – 2.0 Slurry tank: (-1) – 0 Bait hold: -15	2.48	2,211,000	33,872	63,872	3.8
45-60 feet	Fish hold: $15m^3$ Bait hold: $6m^3$ Slurry tank: $6m^3$	4500		2.48	2,236,000	114,912	159,912	2.67
45-60 feet	Fish hold: $20m^3$ Bait hold: $6m^3$ Slurry tank: $6m^3$	6000		2.96	2,425,000	114,912	174,912	2.32
45-60 feet	Fish hold: $25m^3$ Bait hold: $6m^3$ Slurry tank: $6m^3$	7500		2.96	2,446,000	155,952	230,952	2.03
60-75 feet	Fish hold: $30m^3$ Bait hold: $6m^3$ Slurry tank: $6m^3$	7500		2.96	2,469,000	155,952	245,952	2.04

* For RSW tank seawater to fish ratio 1:2

Assessment of quality of Central fish market in Peliyagoda

Official fish samples were collected from 25 fish retailing stalls by Public Health Inspector at Peliyagoda and these samples were analysed for microbiological (*Escherichia coli* and *Salmonella)* and chemical (Total volatile base contact and histamine content) parameters. Seventeen fish samples out of 31 samples were in unacceptable quality based on microbiological and chemical parameters. Legal actions were taken against sellers for selling of unacceptable quality fish at CFM in order to discourage distribution of low quality fish along fish supply chain.

Outcome

- 100% of the samples of harbour basin water were highly contaminated with *E.coli* and 12% of the samples contained *Salmonella* (harbour basin water is used to wash fish and clean boats).
- 96% of the ice samples collected from ice factories contained *E.coli* .
- 8% and 16 % of of ice samples from ice factories contained *Salmonella* and *Listeria* spp. respectively.
- More than 90% of the boat surfaces which directly contact with fish (fish holds and boat decks) contained *E.coli.*
- 10% and 6% of swab samples collected from boat decks and fish holds respectively, were contaminated with *Salmonella* spp.

Recommendations

- Need to improve fish chilling facilities in Multi-day boats
- Systems to sale clean ice
- Supply of adequate amount of clean water
- Use of disinfectants to clean boats and utensils
- Adopt proper fish handling practices in boats and unloading sites
- Modify existing boats to reduce high ice melting loses of existing multiday boats
- Conduct technology transfer workshops for multiday fishers and sellers in Central Fish Market in 2018

PROJECT NO : 3.2.

SANITARY SURVEY AND ASSURANCE OF SAFETY OF EDIBLE BIVALVE MOLLUSKS

Responsible Officers : Dr. Sujeewa Ariyawansa

Oysters and water samples were collected from harvesting areas (Gangewadiya, Kandakuliya Anaiwasal and Janasavipura), and analyzed for microbiological parameters including pathogenic bacteria namely total coliforms, faecal colifoms, *E.coli*, *Faecal streptococci*, *Vibrio cholerae*, *Vibrio parahaemolyticus* and *Salmonella* spp. The microbiological quality of the harvested oysters (n=105) and the surrounding water (n=50) was tested using standard techniques. Oyster samples contained Aerobic Plate Count (APC) in the range of 4.5×10^3 to 9.0×10^7 cfu/g and 25.5% of samples had less

than 5 x x10^5cfu/g. Faecal coliforms varied between not detected (ND) to >1100 MPN/g whereas *E.coli* ranged from ND to 450 MPN/g. Faecal coliforms were not detected in 50% oyster samples. *E.coli* were detected in 42.9% of oyster samples while unacceptable levels (>2.3 MPN/g) were detected in 23% of these samples. APC of water samples ranged from 5.0 x $10^1$to 7.0 x 10^5 cfu/ml. *E. coli* varied from ND to 350 MPN/100ml. Faecal coliforms and *E.coli* were not detected in 28% and 36% of water samples respectively. *Vibrio cholerae* and *Vibrio parahaemolyticus* were not detected in any of oyster or water samples. Of all oyster and water samples tested one water sample (2%) was found to be positive for *Salmonella* spp.

Water samples were collected from Puttalam Lagoon and microbiological quality of water was monitored in monthly intervals (n=80) from January 2017 to November 2017. Analysed parameters were, Aerobic plate counts (Range 1.0 x 10^1 –1.1 x 10^5), total coliforms (Not Detected (ND) – 225 MPN/100mL), faecal colifoms (ND – 65 MPN/100mL), *E.coli* (ND–17 MPN/100mL), *Faecal streptococci* (ND–<110 MPN/100mL), *Vibrio cholera* (ND), *Vibrio parahaemolyticus* (ND) and *Salmonella* spp. (one water sample was found to be positive for *Salmonella* spp.. Faecal coliforms and *E.coli* were not detected in 60% and 72.5% of water samples respectively. Microbiological quality of lagoon water is suitable for natural relaying of bivalves with the exception of a very few instances.

Biotoxins such as Okadaic acid (DSP), Domoic acid (ASP), Brevetoxin (NSP) and Saxitoxin (PSP) were tested in oysters (*Crassostrea madrasensis*) using ELISA method. Oyster samples were collected from 5 sites in Puttalum Lagoon (Anawasala, Gangewadia, Kalpitiya, Janasuriypura and Kandakuliya). 18 bivalves (oyster and clams) samples were collected from January to September in 2017 and analyzed. Results indicate that the quantified concentrations of DSP, ASP and PSP were not exceeded their detection limits (30ng/g, 30ng/g and 3ng/g respectively) and maximum permitted levels (160 µg/kg, 20mg/kg and 800 µg/kg) in oysters intended for human consumption (according to regulation (EC) No 853/2004).

- Protocols for depuration of oysters and clams have been prepared.
- Efficacy of depuration plant installed in Kalpitiya RRC for cleaning of bivalves was monitored. The technique is effective in *reducing* microbial *load in oysters and clams.*
- Microbiological quality data and information of oysters, clams and water from harvesting areas were provided to the competent authority in order to facilitate bivalve exports and domestic sales.
- Sauce and a dried product was prepared from oysters

Recommendations

As far as microbiological safety of bivalves is concerned following recommendations can be made.

- It is recommended to go through the efficient process of depuration before consumption as it makes bivalves safe for consumption.

- There is a high potential for bivalve farming in Kalpitiya and Puttalam as there are many areas in lagoon which is free from pathogenic microorganisms.
- There are areas in lagoon (surrounding Kalpitiya and Puttalam) which are ideal for natural relaying of bivalves
- Technology for preparation of natural oyster sauce has been developed

PROJECT NO : 3.2.1
DEVELOPMENT SEAWEED BASED VALUE ADDED PRODUCTS

Responsible Officers : Mrs. P.S. Jayasignhe,

Ms. Thushini Hemachandra

Mr. Thiruchenduran,

Component 1: Effect of heat in reducing microbial content of fresh edible seaweeds

Project Responsible officer: Ms. Thushini Hemachandra

This study was conducted to check the effect of heat in reducing microbial content. Therefore three different heat treatments were subjected to each seaweed sample. Heat treated samples were tested for *Escherichia coli* in the microbiological laboratory of NARA. Most probable number technique (SLS 516-12:2013) was used.

Seaweed species	***Without heat treatment E.coli* (MPN/g)**	***Heat treatment for 1min E.coli (MPN/g)***	***Heat treatment for 3 min E.coli (MPN/g)***	***Heat treatment for 5 min E.coli (MPN/g)***
Ulva lactuca	>1100	3	0	0
Caulerpa racemosa	43	3.6	0	0
Sargassum wightii	460	3.6	0	0

Table 01: *E.coli* contamination level in *Ulva lactuca, Caulerpa racemosa, Sargassum wightii* before and after heat treatment.

According to the results (Table 1.0), present *Escherichia coli* level in the fresh *Sargassum wightii and Ulva lactuca* samples were higher than 100 MPN/g. Normally *E. coli* in food products at counts more than 100 MPN/g is considered unacceptable from the view point of microbial safety and viewed as a health hazard (El-Hadedy and El-Nour, 2012). Therefore, *Sargassum and Ulva* samples exceed the limits and can be considered as a risk in terms of *E. coli.* After heat treatment (90 ˚C for 1 min) *E. coli* in all the samples was drastically reduced up to about 3 MPN/g. It shows that heat treatment has a significant effect on reducing *E. coli* level. Especially *E. coli* were not detected after 3 and 5 min.

It can be concluded that heat treatment provided for a short time period (90 ˚C for 3 min) can have a significant effect on reducing *E. coli* level even up to non-detectable level.

A mild heat treatment can be used to reduce *E. coli* level of seaweeds before it is used as a raw material in food processing.

Application of the mild heat treatment can be done for the selected three seaweeds (*Ulva lactuca, Caulerpa racemosa and Sargassum wightii)* as those species didn't show any changes in colour, appearance or texture after the treatments.

Research outcome

- Analyzed seaweeds are high in nutritional composition especially in terms of crude protein, crude fibre and mineral content (Ito and Hori, 1989).
- Ulva lactuca species is significantly higher ($p<0.05$) in crude protein content and in magnesium, calcium, iron, copper, zinc levels.
- Caulerpa racemosa species is significantly higher ($p<0.05$) in crude fat, crude fibre, total ash content and zinc level.
- Sargassum wightii species is significantly higher ($p<0.05$) in sodium and potassium levels.
- Escherichia coli can be identified as a risk in terms of food safety of seaweed. Escherichia coli can be reduced up to non-detectable MPN levels by providing seaweed with heat treatment 90 °C for at least 3 min without damaging its textural properties.
- It can be concluded as heat treatment provided for a short time period (90 ˚C for 3 min) can have a significant effect on reducing E. coli level even up to non-detectable level.

Recommendation and further studies

- Heavy metal profile should be analyzed before recommending seaweeds to utilize as a food source.
- Further microbial studies should be conducted in order to determine other water borne pathogenic microorganisms.

Component 2 : Development of seaweed incorporated fish paste

Project Responsible officer: Mr. S. Thiruchenduran

Aim of this study was to develop technologies to maximize the utilization of fish resources harvested by minimizing the disposal of fish discards as wastes. Currently edible discards of Indian Scad (*Decapterus russelli*) used in local canning industry is not utilized. This study was able to develop dietary fiber rich fish paste by utilizing edible fish discards of Indian Scad from local canning industry and edible seaweed species, " Ceylon moss" (*Gracilaria edulis)* as main raw materials.

This product was formulated by mixing ground fish mince with a fine paste of *Gracilaria edulis*, Coriander, Red chili, Turmeric, Pepper, Ginger, Garlic, Green chili, chopped onion, sliced tomato, table salt and water. Fish paste was filled into glass bottles (Thickness-0.65cm, Height-13.22cm) and

pasteurized for 30 minutes in a 91^{0}C water bath to achieve an internal temperature of 85^{0}C for at least 5 minutes. According to sensory evaluation results, fish paste containing 2.5% (w/w) of *Gracilaria edulis* received highest scores for taste, aroma, texture, appearance, flavor and overall acceptability. Crude Protein, crude fat, crude fibre, salt and ash % of this product were 22.45±0.54; 4.19±0.09; 0.74±0.01; 1.22±0.01; and 4.15±0.02, respectively.

Further evaluation of for this product is required by conducting shelf stability studies and market surveys.

Component 3 : Investigation of modified method to increase degree of deacetylation of chitin polymer extracted from shrimp shell waste

Project Responsible officer: Mr. S. Thiruchenduran

Investigation of modified method to increase degree of deacetylation of chitin polymer extracted from shrimp shell waste

Chitosan is one of the most abundant polymers on the surface of the earth, which has been identified as value added by-product from the aquaculture industrial waste. Degree of deacetylation (DD) has been found to influence the functionality of the chitosan molecules in its applications. In commonly practiced extraction method of chitosan from shrimp shell waste, the yield is about 30-40% degree of deacetylation. This study aims to find out suitable low cost technology to produce chitosan with higher DD. The extraction method was based on retorting at 121°C and uses industrial grade chemicals with yields achieved at 87% of DD. The resulted chitosan was analyzed for DD, moisture content, ash content, water binding capacity and fat binding capacity. The analysis results were 44%, 87%; 6.68%, 5.92%; 42.83%, 30.34%; 746.04%, 952.94; 577.19 and 645.81% respectively for conventional and modified method. This modified method can produce high quality chitosan through increased DD and with improved functionality. It is suggested that further studies for applications of chitosan in product development and pilot scale study is recommended before transferring this technology.

Component 4 : Proximate composition of seaweed jam

Project Responsible officer: Mrs. P S. Jayasinghe

In this study the mineral content, proximate composition and storage life of seaweed jam were determined. The Palmyra and seaweed jam mixture had water activity of 0.888±0.03. Crude protein content of jam mixture was (%, wet weight basis), 9.62±2.78. Iodine content of above jam type was found to be 8.3±0.78 mg/kg. The potassium, Calcium, Magnesium and sodium contents were found to be 526 ±67.5, 101.3±21.9, 45.78 and 126.09 ± 62.5 mg/kg respectively. The Cu (0.09 µg/kg) and Zn (0.57µg/kg) were indicated very low levels. Jam mixture was free from toxic chemicals such as Cr, As, Mn and Pb. The total bacterial counts were at the safe consumable level and ranged from $2.3x10^1$ ±0.21 to $6x10^1$±1.7 cfu/g over a six month period at 30 °C. The yeast and mold counts weren't detected during six month shelf life studies.

Results

A slight increase in the total plate count was observed in the analysis during storage time period. However product did not show any symptoms of spoilage such as mold growth, off colors and off odors. Microbiological counts of developed jam was complied with SLSI standards ($P<0.5$) during six months of storage time.

Output

As Sri Lanka is an island bordered by the sea, seaweed culture can be practiced along the coast line and satisfactory amount of seaweeds can be harvested from both the wild collection and the cultured stocks.

Outcome

Coastal communities can engage in seaweed industry and seaweed cultivation can be established as an industry in Sri Lanka. If this is established, seaweed can be utilized in different productions and it will create more employment opportunities for the locals as well.

Recommendation

- Ceylon moss can be incorporated into jam as a fruit pulp and it will provide gelling properties as well instead of application of pectin into it.
- Palmyra fruit, rich in vitamin A and C can be used to improve the sensory qualities of the product and quite tasty pulp to utilize in jam preparation.
- This product can be consumed for six months time period according to the research findings.

PROJECT NO : 3.2.2

DEVELOPMENT OF LOW COST TECHNOLOGY FOR DRIED FISH WITH HIGH BIOLOGICAL VALUE

Responsible Officers : Mr. S. Ariyarathna

Introduction

Traditional dried fish processing method in Sri Lanka is subjected to loss and denature of protein and freshness of fish due to the salting and drying methods. Introduction of new salting and drying method which can be minimized the loss and denature of protein will be a good news for dried fish consumers.

Treatment	Steps	Protein%	Moisture%	TVB-N mg/100g	Water activity
• **New method fish fillets -> Drying inside cooling chamber -> salting -> drying under sun light**	Fresh fillets	25.01	80.94	22.72	0.928
	After drying under cool conditions	25.22	80.18	34.05	0.910
	After salting & drying (Final Product)	55.26	32.64	108.14	0.803
• **Traditional method fish fillets -> salting -> drying under sun light**	Fresh fillets	26.76	80.78	24.69	0.928
	After salting	30.49	56.32	27.59	0.772
	After drying	47.99	37.84	36.81	0.736

Objectives

- Minimization of losses and denature of protein during salting of dried fish
- Minimization of freshness of fish fillets during production of dried fish

Results

Main findings of the study

Removal of water from fish fillets inside the cooling chamber prior to salting process is an effective method to protect more protein within the fish fillets.

Production of smoked dried Tilapia (*Oreochromis mossambicus*) according to FAO Thiaroye Processing Technique and evaluate the keeping quality under different packaging conditions

Objectives

- Production of smoked dried fish using smoking unit establish in NARA according to the FAO Thiaroye Processing Technique.
- Evaluation of nutritional quality and keeping quality of smoked dried fish under different packaging conditions.

Results

- Tilapia drying for 2 days after 4 hours smoking can achieve 0.75 water activity which is the standard water activity of dried fish.
- Shelf life,
  - None packaged - 14-15 Days After drying
  - Vacuum packaged - 21-22 days after drying
  - Aerobically packaged - 15-16 days after drying
- Sensory evaluation indicate that product is acceptable for consumers

Development Activities

Introduction of smoking units

Purpose of the project

Smoked dried fish production is carried out in some areas of the country, especially around the areas of inland reservoirs. They use traditional direct smoking method using locally available wood materials which leads to contaminate and deposition of the harmful chemical on product such as PAH. FAO-Thiaroye processing technique is a keen solution to meet challenges related to small scale smoked fish products processing practices in Sri Lanka. This technique can be introduced to dried fish and smoked dried fish producers existing along the coastal line and around fresh water reservoirs. In addition to that this smoking unit can be used to produce smoked fish which has high potential consumer demand.

Objectives

- To provide 12 numbers of FAO-Thiaroye processing units for selected relevant groups in fisher community.
- To conduct training for selected groups regarding FAO-Thiaroye processing technique and benefits.

Proposed sites to established the smoking units

Districts		Numbers of units
Coastal districts Target for marine fish products (Smoked fish, maldive fish and dried fish)	Matara, Puttalam, Mannar, Jaffna, Batticaloa, , Hambantota	7
Mid country districts Target for fresh water fish products (Smoked fish and dried fish)	Nuwaeliya, Polonnaruwa, Anuradhapura, Ampara , Hambantota	05
Total FAO-Thiaroye processing units		12

Proposed Time line

Duration -18 weeks

Task	Durations in weeks	
	1-4	5-18
Pre preparation /Tender procedure /purchasing	X	
Establishment of FAO-Thiaroye processing unit at selected sites		x
Conduct training programmes		x
Feed back/Quality analysis		x

Work completed

Task	Target	Achievement
Pre preparation /Tender procedure /purchasing of items needed to construction of smoking units		Completed
Site sections	12 sites	8 sites selected
Establishment of FAO-Thiaroye processing unit at selected sites.	12 units	2 units completed
Conduct training programmes	12 programmes	2 programmes completed
Feedback/Quality analysis		

Details of site selected

Sn.No	Address	
01	NARA Regional Research Centre ,Rakawa ,Netolpitiya	Completed
02	Batatha fisheries society ,Batatha	Completed
03	Mahawilachchiya fisheries society,Mahawilachchiya,Anuradhapuraya	-
04	Kaleimahal fisheries society, Walikanda, Polonnaruwa	-
05	Kaludakada fisheries society ,Minneriya, Polonnruwa	-
06	St.Thresa fisheries society,Pukkulama, Puttalam	-
07	Hambegamuwawewa fisheries society,Hambegamuwa, Monaragala	-
08	St.Mariya fisheries society,Kattekaduwa,Jaffna	-

Future Task

Task	Time	Estimated cost Rs. Mn
Selection of four sites	January 2018	.02
Establishment of ten numbers of FAO-Thiaroye processing units	January to end of April 2018	1.85
Conduct 10 number of training programmes	January to end of April 2018	0.75
Feedback/Quality analysis	February to June 2018	1.2
	Sub Total	3.82
Administrative cost		0.1146
Total		3.9346

Summary of the progress

We have received Rs 4,004,100.00 as an advance payment and total expenditure was about Rs.4, 054,032.14 at the end of December 2017. Purchasing of items needed to construct smoking units and site selections were almost completed. Establishment of 10 numbers of smoking units in selected sites and awareness activities will be completed within first quarter of the year 2018. Estimated cost for completion of the project in the year 2018 is about 4 million.

Training/Awareness programmes conducted during year 2017

Date	Name of the progrmme	Aim	Participants	Place	Amount/ Sponsor	Reason for selection the places	Relevant approval
20/01/17	Better fish handling and concept of freshness.	To upgrade the knowledge	Staff from Keells supper	NARA	JayKay Marketings	On request of the Sponsor	DG approval
19-20/08/17	Hyginical preparation of Dry & Maldive Fish	To improve hygienic practices.	Hambantota District Awareness programs	Rekawa RRC	NARA	On request of the Ministry	DG approval
26-27/08/17	Hyginical preparation of Dry & Maldive Fish	To improve hygienicl practices.	Hambantota District Awareness programs	Rekawa RRC	NARA	On request of the Ministry	DG approval
13-14/07/17	Post Harvest Technology and preparation of fish products	To upgrade the knowledge	Puttlum District Awareness programs	Kalpitiya	DFAR	On request of the Sponsor	DG approval
21/10/17	Technology transfer	To improve the reduction of fish quality loss in Multi day boats.	Mannar district	Mannar	NARA	On request of the Ministry	DG approval

28-29/10/17	Production of smoke fish	To provide technical support	Batticaloa Fisher community	Batticaloa	Ministry	On request of the Sponsor	DG approval
04-05/11/17	Production of Maldive fish , salted smoked fish and smoke fish	To Introduce new smoking unit and production of fish products	Rakawa and Bataatha Fiser community	Rakawa RRC	Ministry	On request of the Sponsor	DG approval
12/11/17	Technology transfer	To improve the reduction of fish quality loss in Multi day boats.	Putta lum district	Wennappuwa	NARA	On request of the Ministry	DG approval
14 - 15/12/17	Microbiological analysis of fish & value addition of fish products.	To upgrade the knowledge	Students of The Ocean university of Sri Lanka	NARA	Ocean university of Sri Lanka	On request of the Sponsor	DG approval

Publications

1. P.H. Ginigaddarage, I.H.W. Surendra, W.K.S.R. Weththewa, K.W.S. Ariyawansa, G.J. Ganegama Arachchi, B.K.K.K. Jinadasa, K.S. Hettiarachchi[1]and E.M.R.K.B. Edirisinghe (In press) Microbial and chemical quality of selected dried fish varieties available in Sri Lankan market. Sri Lanka Journal of Aquatic Sciences Vol **23(1)** (2018).

2. A.P.A. Madushani, S. Ariyawansa and C.V.L. Jayasinghe 2017. Assessing of the freshness using Torry meter, chemical, microbiological and organoleptic methods in Skipjack tuna (Katsuwonus pelamis), Indian scad (Decapterus russelli) and Spangled emperor (Lethrines nebulosus). Proceedings of 73rd annual session of Sri Lanka Association for the Advancement of Science. Part 1-Abstracts. pp.146.

3. A.P.A. Madushani, S. Ariyawansa and C.V.L. Jayasinghe 2017. Validating Torry meter by chemical, microbiological and organoleptic methods using Katsuwonuspelamis, Decapterusrusselli and Lethrinesnebulosus. Undergraduate Research Symposium-2017. Wayamba University of Sri Lanka. pp. 70.

4. K. W. S. Ariyawansa, S. Gallage, P. Ginigaddarage, K. Hettiarachchi, G. P.Roshan, C. Madagedara and H. M. P. Kithsiri. 2017. Assessment of microbiological quality of oysters (Crassostrea madrasensis) harvested in different location of Puttalam Lagoon in Sri Lanka.

5. Proceedings of the National Aquatic Resources Research and Development Agency, Scientific Sessions 2017. pp. 55.

6. H.G.P. Sameera, K.W.S. Ariyawansa and B.E.P. Mendis. 2017. Production of silage from fish waste using whey as the inoculum. Proceedings of the National Aquatic Resources Research and Development Agency, Scientific Sessions 2017. pp. 53.

7. Mekhala Ratnayake, P. H. Ginigaddarage, G. J. Ganegama Arachchi, K. W. S. Ariyawansa, Indira Wickramasinghe, K. S. Hettiarachchi, S. Abhayarathne, G. P. 7. Roshan, G. Gunasekare and S. Gallage. 2017. Investigation of pathogenic bacterial contamination of fish handled in Mannar, Sri Lanka. Proceedings of the National Aquatic Resources Research and Development Agency, Scientific Sessions 2017. pp. 56

8. T. H. T. Madhushani, G. J. Ganegama Arachchi, P. H. Ginigaddarage, K. W. S. Ariyawansa, Indira Wickramasinghe, K. S. Hettiarachchi, S. Abhayarathne, G. P. Roshan, G. Gunasekare and Fathima Nizreena. 2017. Quality assessment of Decapterus russelli (Indian scad) fish harvested by multi – day boats in Kudawella and Puranawella in Sri Lanka. Proceedings of the National Aquatic Resources Research and Development Agency, Scientific Sessions 2017. pp. 59.

9. K. W. S. Ariyawansa, D. S. Ariyarathne, M. J. Paththuwe Arachchi, G. S. Chathurika, Mudhitha SenerathYapa and Chathuri Yatawara. 2017. Isolation and characterization of collagen from yellow fin tuna (Thunnus albacares) waste. Proceedings of the National Aquatic Resources Research and Development Agency, Scientific Sessions 2017. pp. 60.

10. P. G. Madusha Dilrukshi, G. J. Ganegama Arachchi, P. H. Ginigaddarage, K. W. S. Ariyawansa, Indira Wickramasinghe, K. S. Hettiarachchi, S. Abhayarathne and Ruchitha Perera. 2017. Quality assessment of imported fish retailed in Sri Lanka. Proceedings of the National Aquatic Resources Research and Development Agency, Scientific Sessions 2017. pp. 61.

11. Ariyawansa,K.W.S.,Ariyarathna,D.S.,PaththuweArachchi,M.J.,Chathurika,G.S.,MudhithaSenerath Yapa and ChathurikaYatawara,(2017),Isolation and Characterization of Collagen from Yellowfin tuna(Thunnusalbacares)NARA scientific sessions, 60pp.

12. Thiruchenduran, S., GanegamaArachchi, G.J., Ariyarathne, D.S., Hemachandra, T.P and Perera, M. R. 2017. Investigation of modified method to increase degree of deacetylation of chitin polymer extracted from shrimp shell waste. NARA Scientific Sessions. 2017. 52.

13. Ekanayake, V.O., Thiruchenduran, S. and Prasanna, P.H.P. (2017) Value addition of recovered edible fish portions of decapterusrusselli by algae incorporated fish paste. Proceedings of Undergraduates Research Symposium 2017, Faculty of Agriculture, Rajarata University of Sri Lanka.

Booklets

1. Hand book on smoked fish products

Testing Services of IPHT

1. Quality Control Laboratory (Microbiological and Chemical units) of IPHT which has obtained accreditation status for several analysis parameters as per ISO/IEC 17025: 2005 Standards. Testing Services of this laboratory have been obtained by industry, especially, fish exporting companies; Ministries, academic institutes and other stake holders. Total of 1482 samples were analyzed for microbiological (744) and chemical (738) quality. Relevant to these samples, 500 Test Reports were issued by IPHT and total testing payments for NARA were LKR 8,725,208.00. Forty percent (40%) of total revenue will be remitted to NARA as royalty payment.

Supervision of undergraduates

1. A.P.A. Madushani BSc (Food Science), University of Wayamba
2. S.B.S.T Perera BSc (Food Science), University of Wayamba
3. K.S Dissanayaka BSc (Food Science), University of Wayamba
4. R.I.W.Weerasinghe BSc. (Fisheries and Marine Sciences), Ocean University of Sri Lanka
5. R. Lasanthini BSc. (Fisheries and Marine Sciences), Ocean University of Sri Lanka
6. I.M.C.N Ilankoon BSc. (Animal Science), University of Peradeniya
7. H.M.U.L Herath BSc. (Animal Science), University of Peradeniya
8. W.M.N Wijesundara BSc.(Microbiology), University of Kelaniya
9. A.Litha BSc (Food Science), University of Wayamba
10. A.A.T. Dilini BSc (Food Science), University of Wayamba
11. W.S.Chamara BSc.(Agriculture),University of Peradeniya
12. W.J.C.M Jayawardana BSc. (Food Science) University of Peradeniya
13. J. Dayangika Sandamali BSc. (Agriculture), Sabaragamuwa University of Sri Lanka
14. I.G.V.Maduranga BSc. (Agriculture), Sabaragamuwa University of Sri Lanka

Socio-Economic and Marketing Research Division







5.8 SOCIO-ECONOMIC AND MARKETING RESEARCH DIVISION

Head of the Division: Mr. K.H.M.L. Amaralal

The main functions of the division include social economic and marketing studies in the fishing industry, including the welfare of the fishermen and their dependents, analysis of fish marketing system and its impact on consumers.

Research projects conducted in the year 2017

1. Cost of production and economic efficiency of marine fishery in Sri Lanka
2. Identification of formal and informal institutional barriers for the development of aquaculture industry in Sri Lanka
3. Socio-Economic Impact of winch introduction to the beach seine fishery
4. The fisheries information centre (FIC) of NARA

Activities

- Under the projects (i) (ii) and (iii) following activities were completed.
  - Data collection
  - Data analysis
  - Report writing/annual publications
- Under the fisheries information center, all inquiries were recorded and answered over the phone or directed to the respective institutes

Program	Project	Allocation(Rs)	Responsible Officer	Duration
Socio-economic & Marketing	Study on Production Cost of Marine Fisheries in Sri Lanka(Project no 1.3)	1 million	Mr. M. M. A. S. Maheepala	One year
	Identification of formal and informal institutional barriers for the development of aquaculture industry in Sri Lanka(Project no 1.15)	1 million	Mr. HD Wimalasena	One year
	Socio-Economic Impact of winch introduction to the beach seine fishery (Project no 1.1.4)	0.5 million	Mr. M. M. A. S. Maheepala	One year
	The fisheries information Centre (FIC) of NARA (Project no 5.9)	1 million	Mr. KHML Amaralal	Continues

PROJECT NO : 1.3
STUDY ON PRODUCTION COST OF MARINE FISHERIES IN SRI LANKA.

Introduction

Marine fisheries sector is an important and the large sub sector (85%)of fishery industry in Sri Lanka and incur varies of cost factors in fishing operations .At present information onthe nature and structure of operational cost in fishing operations are little known or unknown which hindered making development plans and policy decisions for fisheries. Therefore, this study is timely important for the information and data which may be helpful for all stakeholders as well as planers and policy makers for the development of the sector.

Objectives of the study

The main objective of the study is to explore production cost of marine fishing operations in Sri Lanka.

Methodology

This study was questionnaire surveys and primary datawere collected through direct interviews with skippers and boat owners. The total samples were 360representing all main fishery harbors and anchorages through the coastal belt of the country. Data were collected during the time period of January to November in 2017. For the study purposes all boats were categorized into three groups according to the length of the boat.

Outcome

Availability of developed real time data base of production cost of marine fishing operations.

Output

- Final report
- Data base

Results

Deep Sea Fishing Operations :

The annual fish catch, production cost and income of multiday boats in deep sea fishing operations varied according to the size of the boat (Table 1).

Production Cost :

The production cost has had positive correlation with the size of the boat because larger boats deploy more crew members, gears and sophisticated equipment that incurred higher cost than smaller ones.

Profitability :

The highest net income of Rs. 4,231,875 was enjoyed by boats in group 33-40 ft length and the lowest Rs. 2,492,097 by the boats belonged to 28-32 ftwhile that of Rs. 4,202,594for the larger boats, 41-60 ft.

Coastal Fishing Operations :

The annual fish catch, production cost and income of boats in coastal fisheries varied according to the type of the boat (Table 1).

Production Cost :

The production cost has had positive correlation with the type of the boat, mechanized or non-mechanized, in coastal fishing operations. The mechanized boats incurred higher production cost than non-mechanized boats mainly because of fuel cost.

Profitability :

The annual net incomes variation has observed among different types of coastal fishing boats. The highest net income of Rs 447,985 was earned by Out-boat engine fiber reinforced Plastic boats (OFRP)and the lowest, Rs 74,872, byNon-mechanized traditional boats (NTRB) while that of Rs. 222,532 formechanized traditional boats (MTRB).

Annual Averages of Catch, Income, Variable cost, Gross and Net profit (Rs)

Description	Deep sea Fishery (Craft length categories ft.)			Coastal fisheries (craft types)		
	28-32	33-40	41-60	OFRP	MTRB	NTRB
Catch (Kg)	24,276	26,563	32,008	5,971	3,331	1,509
Income (Rs.)	8,217,300	11,926,787	16,964,240	2,239,125	1,099,230	657,965
Variable cost (Rs.)	4,728,659	6,226,836	10,311,815	1,530,480	764,050	320,436
Gross profit (Rs.)	3,488,641	5,699,951	6,652,425	708,645	335,180	260,529
Net profit (Rs.)	2,492,097	4,231,875	4,202,594	447,985	222,532	205,987
Multi-day boats (IMUL) ,Out-boat engine Fibre reinforced Plastic boat (OFRP) Non-mechanised Traditional Boat (NTRB) and mechanised traditional crafts (MTRB)						

Source: Socio-economic survey/SED/NARA/2017

Recommendations:

- It is recommended to control the cost of production of fishing crafts that in operation in both deep sea fisheries and coastal fisheries through applying the low cost concept by integrating scale of economies in operation.

- It is recommended to introduce a program to enhance the skills as well as onboard fish handling of crew members to maintain the quality of fish in order to get better price at the market.

- It is recommended to initiate a policy dialogue with the participation of all stakeholders, policy makers and academicians toachieve economic efficiency in deep sea fishing operations.

- It is recommended to provide advanced technological equipment and ICT facilities to all boats in deep sea fishing operationsin order to minimize the operational cost of production.



NTRB boat

PROJECT NO : 1.15

IDENTIFICATION OF FORMAL AND INFORMAL INSTITUTIONAL BARRIERS FOR THE DEVELOPMENT OF AQUACULTURE INDUSTRY IN SRI LANKA

The foreign direct investment as well as local investment in the fisheries aquaculture sector was remained at a lower level for decades compared to the other sectors in the Sri Lankan economy. Therefore, the contribution to GDP of the sector has been at a lower rate despite the vast potential for growth.

Objective of the study:

This study was carried out to find out the investment barriers in the fishery and aquaculture sector and to propose suitable strategies to overcome such barriers.

Methodology:

The study was based on primary as well as secondary data sources. Moreover, national workshop also convened to discuss the study findings and to incorporate stakeholder suggestions in to the report.

Output(s):

National consultative workshop, final report

Outcome:

Enhanced investments of the fisheries sector

Results of the study:

The investment barriers in the fisheries and aquaculture sectors have two dimensions. They are the barriers general to all sectors of the economy and the barriers specific to the fisheries and aquaculture sector. The overall investment climate and policies directly impact on the investment attraction and retention irrespective of sector of interest. In respect to starting of a business and doing business in Sri Lanka in better position compared to South Asia but compared to Southeast Asian economies is shown lower comparative performance.

For the fisheries and aquaculture investments, land acquisition, environmental clearance and local government approvals are critical barriers. Investment attraction, facilitation and retention are among the areas which have given insufficient attention by the BOI and the authorized agencies in the fisheries and aquaculture sector dealing with investors.

The local investors are not adequately encouraged with policy support compared to incentives offered to the foreign investors. The existing small local investors in aquaculture were perceived that the most critical barriers as entry, operational and technological barriers. Lack of capital and delays in land acquisition are entry barriers while high input costs and inadequate fingerlings supply as operational barriers. Inability of controlling intermittent disease out breaks and low productivity are technological barriers which has adverse impact on local investment. The following recommendations were made and submitted to the Ministry of Fisheries and Aquatic Resources Development.

Recommendations:

- It is recommended to identification and demarcation of state lands suitable for fisheries/aquaculture investments as special economic zones (SEZ) and fulfills legal requirements to lease and setting up of all necessary infrastructures and to be available for all stakeholders.

- It is recommended to undertake IEE/EIAstudies for SEZs and should be available for all stakeholders prior to investment proposal submission.

- It is recommended to initiate a program to provide incentives for local investors for deep sea fishing and value added aquaculture products innovation.

- It is recommended to setting up of a virtual one stop shop (VOSS) for investment process including approval and facilitation. In addition this existing OSS should be extended to cater investor requirements under one roof principal with delegated desks manned by senior officials with vast experience and knowledge in their field.

- It is recommended to prepare complete guides (web based/hard copy) to investors in different languages (English, Chinese, Korean, Japanese etc.).

- It is recommended to worldwide promotion with the help of overseas diplomatic missions by organizing of investor forum annually to address issues related to investment promotion, facilitation and retention.

- It is recommended to expand training and development programs to enhance skills and knowledge of officials whom directly involve in investment services of all related institutions.

PROJECT NO : 1.1.4

SOCIO-ECONOMIC IMPACT OF INTRODUCTION OF WINCH FOR THE BEACH SEINE FISHERY

Introduction:

Beach seine (Madal) is a traditional fishing method which was contributed significantlyin fresh and dried fish to the local market in the past. Beach seine is an inherited fishing technique that was legalized in 1984 by Madal (Beach seine) fishing regulation. This fishery has been changing over the years and recent pastit showed remarkable changes in features of fishing nets (Core nets to Nylone nets), fishing boats (Wallam to mechanize / OFRP). On the other hand changes in hauling system (Labour to winch) has been taken place based on different factors. Although these new development has generated positive impacts for the fishers some are argue that it has generated negative impacts to the fishery resources and environment depriving sustainability of the fishery.

Objective(s) of the study:

This study was planned to find out Socio-economic impacts of introduction of winches to beach seine fishery.

Methodology:

The approach of this study was two dimensions, beach seine operators and the other small scale fishers in the particular location. Beach seiners also sub divided into two groups; winch users and non-users. Two separate questionnaire surveys, one for beach seiners and the other for small scale fishers, were administered in all locations where beach seines being operated. The total samples were 27 for beach seine operators and 37 for other small scale fishers. Data were collected on the basis of economic and social parameters related to the fisheries. Collected data were analyzed using SPSS package and descriptive statistics were mainly used. ANOVA tests were used to show the differences of two types of beach seine fisheries, winch users and non-users.

Output :

Final report

Outcome :

Maximized social and economic benefits of beach seine fishery for fisher community

Results of the study:

All beach seines have been subjected to changein terms of material and instrument used. It was found that fishing nets have changed core rope to nylon nets while basic OFRP to modernized OFRP boats.To haul the netsupported with tractors having a winch is the latest mechanizationbeing introduced to the fishery. It was justified by seine owners due to shortage of labour is major reason for introductionof winch for the beach seine fishery.

The operational cost of seine fishery irrespective of system comprises of labour, fuel and food costs in general.

Table 1: Monthly average operational cost of the beach seine operation.

Operating system	Description	LabourCost	Food	Fuel for the Boat	Fuel for the Tractor	Total Cost
Modernized seine with Tractor and a Winch	Average	588,818	159,272	17,875	34,423	800,388
	St Dev	149,337	125,774	8,759	8,759	
	Min	250,000	100,000	4,500	4,500	
	Max	900,000	600,000	36,750	36,750	
Traditional seine	Average	500,000	147,000	15,180	-	662,180
	St Dev	79,056	37,682	6,940	-	
	Min	400,000	100,000	9,500	-	
	Max	600,000	200,000	25,000	-	

Source: Socio-Economic Survey/SED/NARA/2017

The individual cost of labour, food and fuel for boat all time higher in modernized seine than traditional seine of the fishery operation. Of them the highest cost factor was labour while the lowest was fuel for the boat and the second highest cost factor was expenses on food irrespective of operation system.

Table 2: Monthly average cost, income and gross profit of a beach seine (Rs)

Operating system	Description	Operation cost	Total income	Gross profit
Modernized seine with Tractor and a Winch	Average	826,617	1,161,572	330,681
	St Deviation	246017	310822	188039
	Min	465000	438810	-250000
	Max	1410000	1774000	775000
Traditional Seine	Average	711,880	855,000	143,120
	St Deviation	109497	245204	244761
	Min	539750	500000	-265150
	Max	834500	1100000	350000

Source: Socio-Economic Survey/SED/NARA/2017

The monthly gross profit of the seine operations was 330,681 and 143,120 rupees for modernized and traditional seine respectively but the ANOVA test result revealed that there is no significant differences of gross profits of the both beach seine operations (p>.05). (F 3.648, P .068)

Results further revealed that about 80% of Small scale fishers who were fishing using OFRPand NTRB boats at the same area where beach seines are operatedhad no objections and accepted the use of tractors with winchesas for the remedy for labour shortage and hauling time efficiency but opposedto tractors used without winchesfor hauling net for the fishery due to caused damages to the beach and environment.

Recommendations:
It is recommended a comprehensive study to find out suitability of modernization of beach seine fishery for the sustainable development of the coastal fishery.


Traditional method of pulling fishing nets


Latest technique of pulling fishing nets (winch operation)

PROJECT NO :5.9
THE FISHERIES INFORMATION CENTRE (FIC) OF NARA

Introduction:
Socio-economic Division maintains the Fisheries Information Center (FIC) of NARA since 2013 aiming to provide data and information related to the fisheries industry of Sri Lanka and its developments for the board spectrum of users in locally and internationally through established hotline of 07 10 10 10 10 which is activated in 3 languages during the whole day.

Objective(s):
To provide necessary data and information for stakeholders and other interested parties those who are interested in Sri Lankan fisheries industry.

Output(s):
Provide real-time information through leaflets, calls and posters

Outcome:
Availability of real time data and information access for the users.

Results:

The end of the year 2017, a total number of 351 queries were received through the hot line 07 10 10 10 10 of fisheries information Centre from different respondents all of them were resolved. All the queries in general are categorized in to five groups. Numbers of queries received and the percentages under each group are given in the bellow table.

Numbers of queries received and solved under each information criteria

Information criterion	Number of calls received	Percentage
Consumer and Industry related Services	152	43%
Academic and Research Related Services	84	24%
General Complains and Comments	66	19%
Fisherman Welfare and Disasters Related Services	34	10%
Trade and Investment Related Services	15	4%
Total	351	100%

All queries received were successfully solved out with the assistant of NARA scientists, officials of Ministry of Fisheries and Aquatic Resources Development (MFARD), Department of Fisheries and Aquatic Resources (DFAR), National Aquaculture Development Authority (NAQDA) and other relevant officers from the governmental and non-governmental sectors.

To promote the information center among stakeholders of fisheries sector more than 10 banners were displayed in the fisheries harbors and 1000 of leaflets were distributed in harbors, landing sites, fisheries inspectors' offices, and other governmental and non-governmental office premises which are located in the coast line of Sri Lanka.

Recommendation:

It is recommended to further expansion of dissemination of data and information for the users through establishing separate own web portal.

Special Projects

PROJECT NO : 01

WORLD FISHERIES DAY CELEBRATION– 2017

Introduction:

World fisheries day being celebrated on 21st November each year all over the world for the betterment of fisher community. Sri Lanka also joins hands with world in celebrating world fisheries day and Ministry of fisheries advised NARA to organize main function in Negombo for 2017 celebration. On behalf of NARA, socio-economic division which mandate is closely related was advised to involve and organize this event.

Results:

The following events were organized and conducted with collaboration of RRC of NARAin Negombo.

i) One medical camp in Kuttiduwa and over 200 people from fishing community were received treatments and spectacles, the program was funded by Port City project.

ii) 60 school children under age 12 years were given one school bag and 10 exercise books each. Children were selected from fishing community with the help of GN of the area.

PROJECT NO : 02

SKIPPER TRAINING PROGRAM

Introduction:

Offshore/Deep Sea fisheries are identified as fishing beyond the territorial waters extending up to the Exclusive Economic Zone (EEZ) while fishing beyond EEZ known as high sea fisheries. The industry provides over 218,000 direct and 250,000 indirect employments respectively and the total marine fish production of the country in year 2015 was 486,170 Mt and of them 302,300 Mt came from coastal fisheries while the rest (183,870) from the offshore/deep sea fisheries (NARA, 2015). The contribution of the offshore/deep sea fisheries to the total marine fish production of the country has increased steadily over the years.

Different length categories i.e. 28th to 60 feet of fishing boats are operating in offshore/deep sea fisheries and have been increasing over the years. In 2015, there were 3,558 offshore/deep sea boats operating in the deep sea fisheries (NARA, 2015). Approximately there are 10,000 active skippers who involved in offshore/deep sea fisheries at present. In the offshore/deep sea fisheries of Sri Lanka, the main commercial fish catches are not an exception to the issue of overexploitation and result in decreasing the productivity in recent past. There are many factors that contributing in decreasing productivity and of them skipper skills, technical know-how and management ability are critical. It has been proven empirically that skilled skippers catch more fish than unskilled skippers. Thus training of skippers who involved in offshore/deep sea fishing operations is considered timely. This training program is expected to not only improve the skills of skippers but also improve the livelihood status of fishers.

Objective :
The main objective of this program is increase skills and technical know-how of skippers of multi-day vessels for sustainable utilization of marine resources and up liftmen of socio-economic status of fishers in offshore fisheries in Sri Lanka.

Results:
Organized andconducted 4 training programs in Tangalle with the help of Ocean University of Sri Lanka. 100 multiday boat skippers were trained under the programs. After this 7 days programs all skippers were given a certificates issued by Ocean University.

Recommendation:
It is recommended to continue and expand the training program for the betterment of fishers and fisheries industry of the country.

PROJECT NO : 03
WEWAK SAMAGA GAMAK (KALAPUWAK SAMAGA GAMAK)

Under this national program socio-economic division of NARA was offered to conduct socio-economic surveys for Anawasal in Puttalam district, Kokkilai in Mulathive, Panama in Ampara district and Rekawa in Hambantota district.

Objective:
To identify socio-economic stsus of fisher community in Anawasal, Kokkilai, Panama and Rekawa lagoons and preparation of socio-economic profiles.

Results:
Preparation of Socio-economic profiles of all those lagoons were completed and all relevant data and information were submitted to the Ministry of fisheries.

PROJECT NO : 04
PUBLICATION OF FISHERIES INDUSTRY OUTLOOK 2016.

The 'Fisheries Industry Outlook is an annual publication of the Socio-economic and Marketing Research Division (SED) of the National Aquatic Resources Research and Development Agency (NARA).The 'OutLook' comprised of data and information on the current status of fisheries sub-sector with special emphasison production, trade & marketing and consumption of fish and fishery products of Sri Lanka. This is the all in one hand book of fishery industry statistics of Sri Lanka. Fisheries industry outlook is annually published as an online publication and can be reached through the NARA website.

Results:
Published Fisheries Industry Outlook 2016.

Publications
Abstracts Published

1. M.M.A.S. Maheepala and NoyelKalubowila (2017). Indian Poaching in Sri Lankan waters and Sustainable Goal (SDG) 14 targets, In 4th International Conference on Poverty and Sustainable development 2017, Colombo.

2. De Silva D.W.L.U, Wimalasena HD ,Sandaruwan K.P.G.L,Amaralal K.H.M.L,**(2017)**, Socio-economic and livelihood aspects of fisheries in Panama Lagoon of Sri Lanka. In Proceedings of the NARA Scientific Sessions, 27th July, 2017, Colombo, Sri Lanka. P.67

3. Wimalasena H.D., De Silva D.W.L.U, Sandaruwan K.P.G.L (2017). Socio-economic aspects of indirect fishery workers with special reference to Negombo fisheries district in Sri Lanka. In Proceedings of the NARA Scientific Sessions, 27th July, 2017, Colombo, Sri Lanka. P.69
4. Sandaruwan K.P.G.L., DE SilvaD.W.L.U, JayasingheG.D.T.M,Jinadasa B.K.K.K(2017),Socia-economic determinants of the fish purchasing decision and consumption behavior in GampahaDistrict,Sri Lanka. In Proceedings of the NARA Scientific Sessions, 27th July, 2017, Colombo, Sri Lanka. P.70

International Publication

1. D.W.L.U. De Silva, Sandaruwan, K.P.G.L., Wimalasena, H.D., and Amaralal K.H.M.L.,(2017). Livelihood constraints of fishers of Puttalam lagoon in Sri Lanka. In: Proceedings of International Symposium on Agriculture and Environment, 2017, Faculty of Agriculture, University of Ruhuna, 202-204

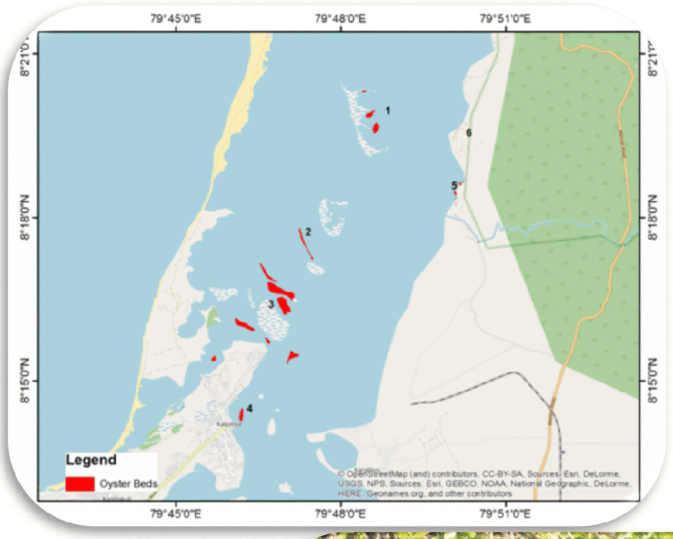
2. Amaralal K.H.M.L., Sandaruwan K.P.G.L(2017).Daily routine activities of fisher's wives and its implication on fisheries industry in Sri Lanka, World Sea food congress ,Sep 2017, Iceland.

Trainings

1. Two scientist, DWULDe Silva and KPGL Sandaruwan, were selected and approved to undertake their M.Sc studies at the University of Peradeniya, Sri Lanka.

2. One research assistant, ViduraSanjayaGunarathne, was participated in Seminar on ICM promoting Comprehensive Economic Strength of Maritime Cities for Developing Countries from 23rd October to 11th November 2017 in Fujian Institute of Oceanography, China.

Monitoring and Evaluation Division







5.9 MONITORING AND EVALUATION DIVISION

Head of the Division : Mr. A.B.A.K. Gunaratne

The Monitoring and Evaluation division is responsible for project planning, monitoring and evaluation. It performs the duties of ensuring effective monitoring, evaluation and coordination of the research programmes. Preparation of the action plan, monthly progress monitoring of research projects, compilation of annual report are the main responsibilities of the division. Information Technology unit, Library and Information unit and Extension unit are placed under the Monitoring and Evaluation division.

Information Technology unit

The mission of the Information Technology Division is to provide the highest quality technology-based services, and support to the organization for its strategic goals and objectives as it applies to research activities and provide effective technology support for audio/visual, multimedia, desktop and web based applications and services.

Information Technology Division conducts research using Geography Information system (GIS) and Remote Sensing (RS) for resources planning and identify suitable areas for aquaculture development and forecasting. GIS technologies applies in the diverse fields and committed to delivering high-quality spatial and attribute data to the internalresearches as to allow better decisions to be made based on the best available information. Information Technology Division acts as a store room of spatial data of marine and terrestrial areas. Division is intended to facilitate as a platform to pool all data/information available in respect to aquatic resources, environment and users and develop products for environmental friendly economic development and scientifically based management of aquatic resources/environment.

The Division is responsible to provide all aspects of IT and systems implementation for information gathering, processing, sharing and dissemination among all stakeholders for management, conservation and development of aquatic resources. It provides expertise in computing hardware and software support as well as LAN (Local Area Network) and WAN (Wide Area Network) connectivity to the staff and administrative support of computer networks. And also ITD maintains IT contracts and software licenses, and coordinates the procurement of IT related hardware and software.

Activities undertaken

Programme	Project	Allocation (RsMillion)	Officer Responsible	Period	
				From	To
Open access to knowledge and dissemination of information	5.10.1 Internet services and online information system	3.4	A.B.A.K. Gunaratne	2017	

	5.10.2 NARA Scientific Session2017	1.5	A.B.A.K. Gunaratne	2017
	5.10.6 Monitoring of research project	0.18	A.B.A.K. Gunaratne	2017
Generate employment opportunities and improve quality of the fisheries community	1.9.2 Zonation of Puttalam Lagoon for Oyster Culturing	1.6	D.D.D.Weragodatenna	2017

PROJECT NO: 5.10.1
INTERNET SERVICES AND ONLINE INFORMATION SYSTEM

Main objective of the project is to disseminate the information via World Wide Web and to provide other Internet services for scientific staff of NARA and its stakeholder with a view of facilitating information sharing.

Launched a new web site for NARA which was developed using wordpress. The site is consisted of nearly 100 pages including vision, mission, details of divisions, staff, research projects, services, news, etc. Mail servers were upgraded during the period. Staff engaged with PC assembling, repairing and upgrading, 55 computers were repaired, 5 computers assembled and 2 were upgraded. Software, network and configuration issues resolved day to day.

Inform Database that used to evaluate research cost of the institutions engaged in CARP network, was submitted to CARP. Expected target was achieved during the period.

Information on human resource and financial statment was submitted to the National Science Foundation and NASTEC for the Research and Experimental Survey 2016.

Progress (%) : Physical : 100% Financial: 100%

PROJECT NO: 5.10.2
NARA SCIENTIFIC SESSION2017

The Scientific Sessions 2017 was held on 27th July 2017 at the Auditorium of National Aquatic Resource Research and Development Agency (NARA), Colombo 15, Sri Lanka. The session theme was "Diversification of Aquatic Industry for Development" and sessions were accommodated on a wide range of themes, including Fisheries and Aquaculture, Aquatic Biotechnology and Animal Health, Oceanography and Hydrography, Fisheries Socio-Economics and Marketing, Aquatic Food Technology, Conservation and Management of Aquatic Environment.As the leading research

organization in the living and non living aquatic resources sector, NARA has immensely contributed to knowledge base of the sector by conducting high quality research on par with national and international standards.

The Inauguration ceremony was graced by His Excellency Mr. Kenichi Suganuma, Ambassador of Japan to Sri Lanka.Guest of honour speech was delivered by Prof. Harindra Fernando, University of Notre Dame (U.S.A).Totally 58 abstracts were accepted to publish in the proceedings of NARA Scientific Sessions 2017. Presenters included a diverse array of scientists in the NARA, universities and research institutes in Sri Lanka and Session speakers inspired many conversations and the exchanging of ideas on what type research needs to be carry out to ensure healthier aquatic environment for the economic growth.

Prof. (Miss) P.R.T. Cumaranathunge, University of Ruhuna, Prof. D.S. Jayakody, Wayamba University of Sri Lanka,Dr.J.K.Rajapaksha, NARA, Prof.E.I.L.Silva, Chairman, Water Resources Science and Technology, Prof. K.K.D.S. Ranaweera, University of Sri Jayawardanapure who are eminent researches in Sri Lanka were chairpersons of the sessions.





PROJECT NO: 5.10.6

MONITORING OF RESEARCH PROJECT

Totally 30 research projects included to various thematic areas implemented during 2017 were monitored in monthly.

PROJECT NO: 1.9.2

ZONATION OF PUTTALAM LAGOON FOR OYSTER CULTURING

Introduction

Oyster beds located in intertidal water serve as an important economic recourse to the coastal community while many essential functions provide to the environment, including water filtration, coastal belt stabilization and habitat for other plants and animals as well. Anthropogenic factors such as coastal development and associated waterway usage are suspected of significantly altering the extent and health of the oyster resources. Therefore Effective conservation and management of oyster beds is essential. However it dependent on an understanding of their abundance, distribution, condition, and change over time. Consequently zonation of Puttalam Lagoon using GIS technology considering environmental parameters is significant in order to long term management of oyster beds and farming.

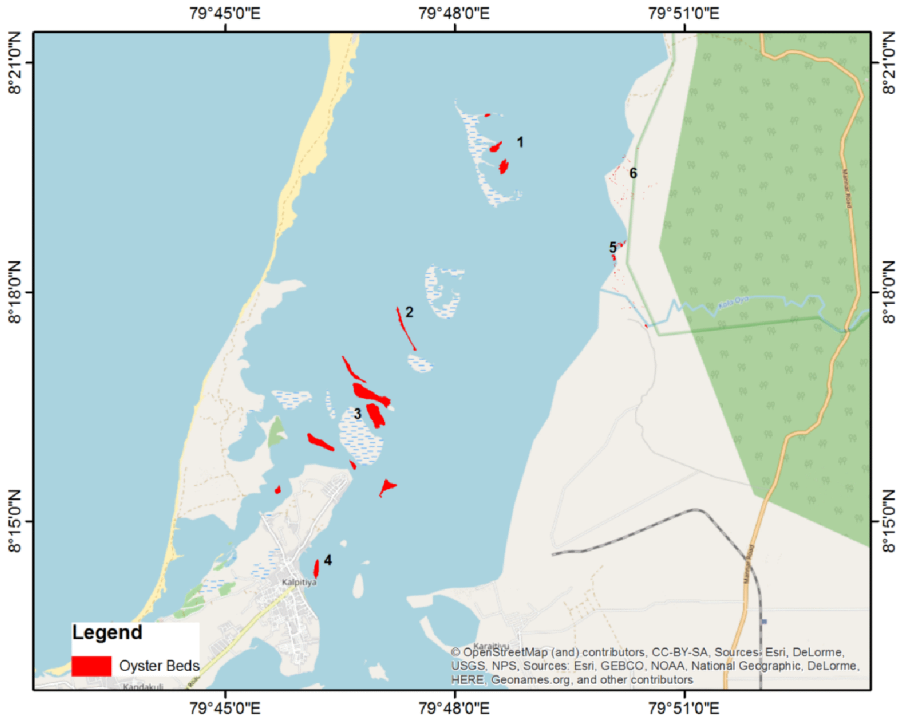
Objective

- Demarcating and mapping of the oyster beds in Puttalam Lagoon.
- Establish a baseline map layer and database for the current extent of oysters in Puttalam Lagoon
- Sharing the data and information among the stakeholders who are working on oyster industries.
- Zonation of Puttalam Lagoon for oyster culturing

Results

Spatial distribution of oyster beds in Puttalam Lagoon

The anlysis shows that totally 81 ha of areas covered by oyster beds in Nothern part of Puttalam Lagoon, around island of Ippanthive (1), Sinnaarichchalai (2), Irumative (3), Kalpitiya (4) Mouth of Kalaoya (5) and along Pomparippu Aru as shown in following figure.



Spatial distribution of oyster beds in Puttalam Lagoon

Zoning of Puttalam Lagoon for oyster farming

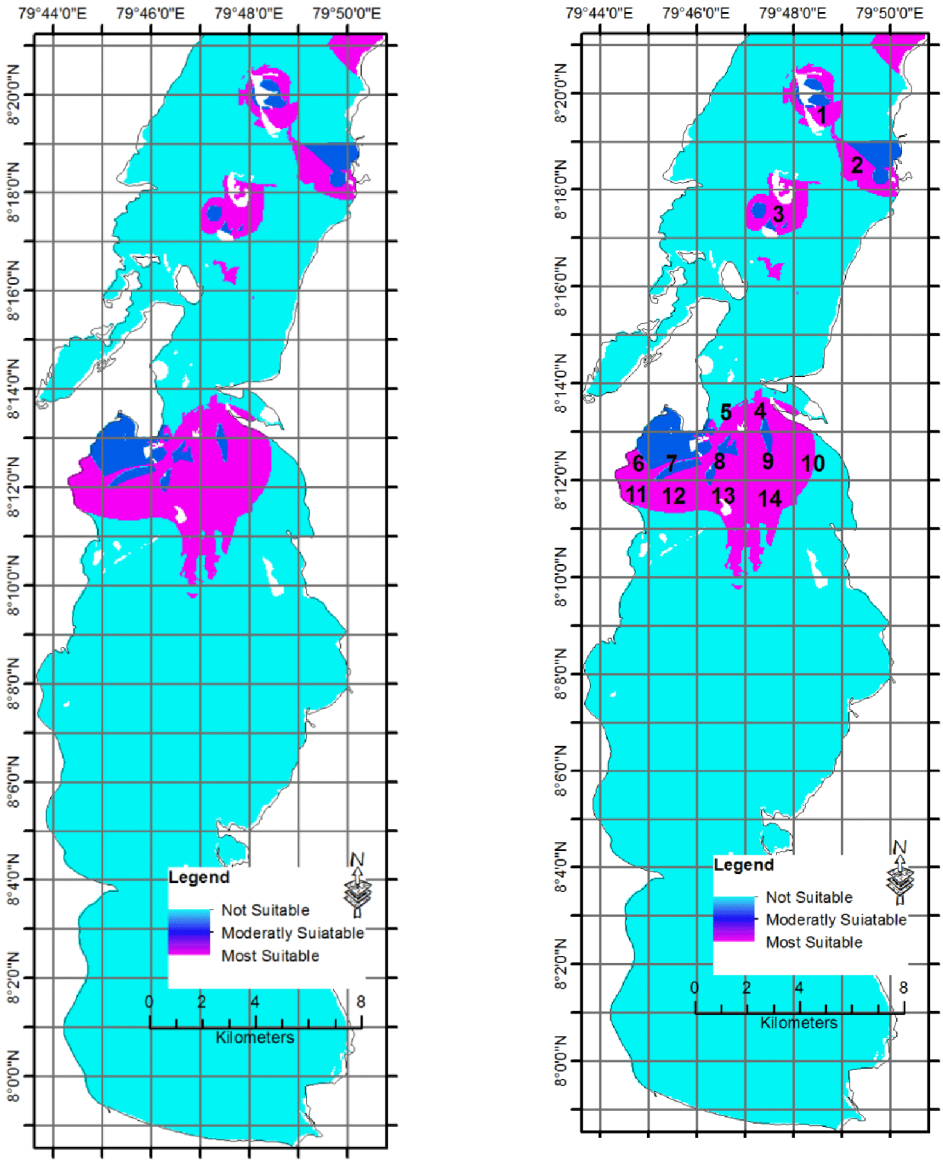
Suitable areas obtained through Weighted Overlay Analysis are divided in to major zones as:

1. Oyster Culturing area
2. Brood stock growing area
3. Depuration area

   Suitable areas with geographic coordinates are given in following table



Oyster beds located at Puttlam Lagoon



Site Suitability for oyster culturing, depuration and brood stock growing

Areas suitable for brood stock growing;

Location/Grid Number	**Geographic Coordinates**		
	Upper Left	Bottom Right	Total Area (sqkm)
1	N 8^0 20' E 79^0 48'	N 8^0 19' E 79^0 49'	3.24
2	N 8^0 19' E 79^0 49'	N 8^0 18' E 79^0 50'	3.24
3	N 8^0 18' E 79^0 47'	N 8^0 17' E 79^0 48'	3.24

Areas suitable for Oyster Farming;

Location/Grid Number	**Geographic Coordinates**		
	Upper Left	Bottom Right	Total Area (sqkm)
4	N 8^0 14' E 79^0 47'	N 8^0 13' E 79^0 48'	3.00
5	N 8^0 14' E 79° 46' 8"	N 8^0 13' E 79^0 47'	1.7
6	N 8^0 12'6" E 79° 44' 37"	N 8^0 12' E 79^0 45'	1.9
7	N 8^0 13' E 79^0 45'	N 8^0 12' E 79^0 46'	3.24
10	N 8^0 13' E 79^0 48'	N 8^0 12' E 79° 48' 18"	1.6
11	N 8^0 12' E 79^0 44'20"	N 8^0 11'24" E 79^0 45	2.99
12	N 8^0 12' E 79^0 45	N 8^0 11'24" E 79^0 46	3.00

Areas suitable for Natural Depuration;

Location/Grid Number	Geographic Coordinates		
	Upper Left	Bottom Right	Total Area (sqkm)
8	N 8^0 13' E 79^0 46'	N 8^0 12' E 79^0 47'	3.24
9	N 8^0 13' E 79^0 47'	N 8^0 12' E 79^0 48'	3.24
13	N 8^0 12' E 79^0 46'	N 8^0 11' E 79^0 47'	3.00
14	N 8^0 12' E 79^0 47'	N 8^0 11' E 79° 47' 38"	3.10

Conclusion

With considering the environmental parameters including water quality (Microbiological, Physio-Chemical and Heavy Metal), water depth, existing oyster beds, access to the road and canal outlets (from urban and aquaculture ponds), site suitability analysis was performed using Weighted Overlay Analysis, that is available in ArcMap 10.2. Weight was assign for each individual parameter obtained by Analytical Hierarchy Process (AHP) technique during the analysis. Suitability classes were classified as most suitable, moderately suitable and not suitable. Suitable areas are divided in to major zones as: Oyster culturing area, Brood stock growing area and Depuration area. The analysis is shown that totally 9.7 sqkm is most suitable area for brood stock growing while 17.4 sqkm and 12.5 sqkm for Oyster farming/culturing and depuration respectively.

Progress (%) : Physical : 100% Financial: 100%

Technical Committee

No	Technical Committee	Date
1	Purchase of Laptop Computer	28/12/2017
2	Purchase of Server and Laptop Computer NIOMS	20/12/2017
3	Purchase of MS Windows Server 2016	20/12/2017
4	Colombo Seafood Festival 2017	30/11/2017
5	Stakeholders Consultation Workshop Lunch & Refreshment Sessions 2017	23/11/2017
6	Procurement of Printing for Nilsayura Newsletter - MBRD	20/11/2017
7	Procurement of Tablet PC	16/11/2017
8	Procurement of Log book printing CENARA phase II	09/11/2017
9	Installation of CCTV Cameras	31/10/2017
10	Procurement of Notebook Computer	11/10/2017
11	Purchasing for the year 2016 - Scanner 2017	04/10/2017
12	Procurement of color Printer A3 - 2017	20/09/2017
13	Procurement of Firewall	25/08/2017
14	Procurement of Multimedia Projector	23/08/2017
15	Workshop on Coastal Fisheries Statistic & Collection - MBRD	11/08/2017
16	Purchasing for the year 2016 Scanner	09/08/2017
17	Procurement of (NARA LOGO Printed) Cup & Sources	02/08/2017
18	Purchase of Computer Parts & Software main file	24/07/2017
19	Procurement of an malware scanner for Local Area Network	17/07/2017
20	NARA Scientific Sessions 2017-Quotations for Lunch & Tea	14/07/2017
21	Request for Computer Parts & Software - DDG Office	16/06/2017
22	Hard Disk Main File 06 -2017	14/06/2017
23	Procurement of Computer Servers & Accessories	30/05/2017
24	Computer Parts Main File 05 2017	05/05/2017
25	Procurement of Printers 05 Nos (Finance,IARAD, P & S)	31/03/2017
26	Security Services for NARA 1	14/03/2017
27	Hard Disk Main File	01/03/2017
28	Purchase of Pen Drives 16GB & 64GB	01/03/2017

Workshops/exhibitions organized

1. SAARC Workshop on Best Management Practices in Aquaculture: capacity building and policy development

SAARC Regional Consultation on "Best Management Practices in Aquaculture: capacity building and policy development" workshop was held from 19-21 September 2017 at Goldi Sand Hotel, Negombo, Sri Lanka.The workshop was jointly organized by SAARC Agriculture Centre (SAC), Dhaka, Bangladesh and National Aquatic Resources Research and Development Agency (NARA), Sri Lanka. Participant countries are included, Bangladesh, Bhutan, India, Maldives, Nepal, Pakistan and Sri Lanka. The inauguration ceremony was held on 19th September 2017 and special guest speech was delivered by Dr. Jerry Jayawardene, Chairman, Sri Lanka Council for Agricultural Research Policy. Open ceremony was grace by Hon. Dilip Wedaarachi, State Minister, Ministry of Fisheries and Aquatic Resources Development.





2. Colombo Seafood Festival 2017

The Colombo Seafood Festival 2017 was held from 8th- 10th December, 2017, at Green path, Open Air Theatre, Viharamahadevi Park. Theme of the exhibition was "Gathering of food producers for a blue economy based development". Inauguration ceremony was graced by His Excellency Maithripala Sirisena, President of the Democratic Socialist Republic of Sri Lanka. Hon. Mahinda Amaraweera, Minister of Fisheries & State Minister of Mahaweli Development, Hon. A.H.M Fowzie, State Minister of National Integration and Reconciliation. Seafood products, fish therapy programmes, art competitions, enormous variety of fisheries related exhibits, and other entertainment programs amused the participants.





EXTERNAL FUNDED PROJECT

PROJECT NO : 01

MAPPING AND SPATIAL INTERPRETATION OF SENSITIVE COASTAL AND MARINE ECOSYSTEMS COVERING THE COASTAL AREA FROM ARIPPU TO POINT PEDRO OF NORTH PROVINCE IN SRI LANKA.

Total value of the consultancy	Rs 430,000.00
Duration	Jan – Dec 2017
Study team	Mr. A.B.A.K Gunaratne, Director, M&E Ms. D.D.D Weragodatenna, Scientist, M&E

PROJECT NO : 02

DATA BASE DESIGN AND WABPAGE DEVELOPMENT FOR PETROLEUM RESOURCE DEVELOPMENT SECRETARIAT

Total value of the consultancy	Rs 1,000,000

Supervision of university student

Industrial Training on GIS and Remote Sensing

1. H.P.M.M.Herath, Department of Geography, University of Colombo, From October 2017 – January 2018

2. M.V.G.R Indika, Department of Geography, University of Colombo, From October 2017 – January 2018

3. Charith Madusanka, Department of Zoology, University Sri Jayawardhanapura, From Nov 2017 – Feb 2018

Publications

1. D.D.D.Weragodatenna, M.G.W.M.K.Gunarathne and A.B.A.K.Gunaratne, 2017, Identification of spatial distribution of coral reef in Pigeon Island, Trincomalee by remotely sensed data,Proceedings to the Journal of National Aquatic Resources Research and Development Agency, NSS 2017, 27th July 2017

Reports

1. Mapping and spatial interpretation of sensitive coastal and marine ecosystems covering the coastal area from Arippu to Point Pedro of North Province in Sri Lanka, Final Report, November 2017 submitted to IUCN

Library and Information

Overview

NARA Library is a Special Library acting as an information & reference centre holding a special collection of Fisheries and Aquatic Resources related information in physical and electronic media. The division ensures the information needs of the scientists and scholars strengthening the resource and also sharing relevant and current knowledge to achieve the mission and goals of the NARA and also to the sector. The Online Public Access Catalogues (OPAC) was updated. The collection were strengthened by purchase of resources, donations, inter libraries exchanges and downloads from the web and freely available e-resources using subject gateways. NARA Library is serving effectively and competently in the world of rapid evolution of information.

Activities undertaken

Project	Activities	Allocation	Officer Responsible	Period (from-to)
Collection Development of Library Resources	Procurement of books, Journals (printed /electronic) and CD-Rom Collecting Research Reports and Papers Obtaining of library resource donation E-downloads	2.00	BGS Kariyawasam RS Liyanarachchi BGS Kariyawasam -do- BGS Kariyawasam RS Liyanarachchi	Jan- Dec Jan-Dec
Collection Management of the library	2.1 Editing and updating library catalogues 2.2. Entering data to New library Development software 'KOHA' 2.3 Subject Classification & filing of library resources 2.4 Compilation of e-repository collection		BGS Kariyawasam Manori Rupasinghe Menaka Karunaratne -do- BGS Kariyawasam RS Liyanarachchi Manori Rupasinghe	Jan– Dec
Reference Services	3.1 Current Awareness Services (CAS)		BGS Kariyawasam	Monthly

	3.2 Selective Dissemination of Information Service (SDI) 3.3 Information Retrieval Services 3.4 Indexing Services 3.5 Literature Survey 3.6 Inter libraries exchange services		BGS Kariyawasam BGS Kariyawasam RS Liyanarachchi BGS Kariyawasam	Jan- Dec
Library Cooperation	4.1 Library membership British council & ITI		BGS Kariyawasam RS Liyanarachchi	Jan- Dec
Other services	5.1 Multi copying services (Photo copy /Scanning)		Menaka Karunaratne Manori Rupasinghe	Jan- Dec
Publishing Journal & Publicity Service	Sale & free distribution of NARA Publications Re-print of NARA Publications		RS Liyanarachchi Manori Rupasinghe Menaka Karunaratne BGS Kariyawasam RS Liyanarachchi	Jan- Dec

PROJECT NO : 01

ACQUISITION OF LIBRARY RESOURCES

Strengthened the Library resources by purchasing, donations, exchanges and electronic downloads according to the requests of the scientists of NARA. Also, collected information relevant to NARA.

Purchases:

1. 03 Journals were requested for the year 2016, out of them only 01 were subscribed & 02 were renewed.
2. Book Titles – Purchased 69 Nos.
3. Renewed payment for purchasing AGORA database and National Geography for this year. Online subscription of Natural Products (1999-2017) was done.

Donations & Exchange :

Received 04 Books, 56 Reports, 98 Newsletters, 49 Travel Reports, Research Reports 20 and 05 CD-ROMs.

Progress : Physical : 100% Financial :100%

PROJECT NO : 02

RESOURCE MANAGEMENT

The resource acquired, were catalogued and classified manually and also entered to the electronic catalogue and accessible not only to the NARA but also to the public. Other indexes (electronic) were also updated regularly.

Library resource referral service was accessible to the scholars using Open Public Access Catalogue (OPAC). Journal Article Index (JAI) database was updated. Started to enter data for the new database (KOHA)

PROJECT NO : 03

REFERENCE SERVICES

Information Retrieval

In order to retrieve from Journal articles, Postgraduate theses, Research reports, Research articles and Newspaper clippings databases were updated electronically and were compiled indexes using WINISIS & Alice software. Summary of data entered for the year as given below.

Name of the Database	Quantity of Data
Koha Database	5460
Research Reports	203
Theses	79
Sri Lanka Reports	248

3.1 Collected information for literature surveys for the following titles –

- Molecular detection
- Fish Processing
- Corporate Governance
- Sea Food
- Aquaculture Products
- Fish Spoilage bacteria
- Food Engineering
- Weaning food
- Fish Statistics
- Fish Nutrition
- Water Quality
- Aquaculture (Mud Crab)
- Ocean Pollution (microplastics)

Replied for the information requests made by users over the phone and also via email.

3.2 Under National Digitization Project, Electronic Article database was started using DSPACE software.

3.3 Library has provided services for the Scientists, Researchers, Postgraduates and Undergraduates who arrived from different institutions and universities. The Number of users visited was 553nos. 80 articles were supplied under SDI services.

3.4 Document Delivery Service - Library has joined for the British Council Membership programme and Under selective dissemination of Information service provided 12 nos research reports provided for Nara Scientists from co-operative libraries

3.5 Library has provided photocopy services - the total amount received through photo-copying during the year was Rs. 3120.00/= and 392 Pages for free of charge for internal readers

Progress : Physical :100% Financial :-%

PROJECT NO : 04
NATIONAL DIGITIZATION PROJECT

4.1 Completed scanning and entered data to the Library Management System.

Progress : Physical :75% Financial -%

PROJECT NO : 05
PUBLICATION AND PUBLICITY SERVICE

Called for quotations to reprint the following books and posters.

Books:

1. විසිතුරු මත්ස්‍ය වගාවේ ලෙඩ රෝග හඳුනා ගැනීම හා පාලනය.
2. විසිතුරු මත්ස්‍ය වගාව සඳහා ටැංකි පිළියෙළ කිරීම නඩත්තු කිරීම හා ජලතත්ව කලමනාකරණය.

Posters:

i. Discuss Fishes
ii. Mangroves of Sri Lanka
iii. Gold Fishes

Sales of NARA publication were done by the library & the total amount received was Rs. 89,147/=.

Progress : Physical : 7 5% Financial : -%

PROJECT NO : 06

TRAINING PROGRAMMES, WORKSHOPS & COMMITTEE MEETINGS ATTENDED :

Local

Workshop :

1. Participated two officers for the workshop on Information searching through Internet organised by SLLA.

2. Participated National Conference on Library and Information Sciences organised by SLLA.

3. Participated Workshop on DSpace Software for Institutional Repositories, Organized by NSF.

4. National Library symposium organised by National Library of Sri Lanka.

Progress : Physical : 75% Financial : 50%

Media and Extension Unit

Objectives of the extension service are,

- Transfer the useful technology experiences and knowledge obtained by the researchers to fishermen and other stakeholder.
- Awareness – Building program
- as in a broader context are designed to educate stakeholders and to create an interest and awareness among the general public.
- To provide fishermen with the latest research result and fishery technique for their Socio-economic betterment.

PROJECT NO : 5.10.5
EXTENSION SERVICES

The unit carried out public awareness programs, providing auditorium facilitates, printing services for printing Posters, Leaflet report, forms etc.20 Requests had been received from various institutions to take part their exhibitions. However, only 05 exhibitions could be attended due to financial constraints.18 Educational visits (schools, navy & government institution) consisting more than 1000 students & officers were noted during the year.

Educational Visit

No	Institution	No of participhents	Date
01	Junior Naval Officers- NAVY Head Quarters, Colombo 01	20	14th February 2017
02	Udupila Weera Vijayaba M.V, Delgoda	200	10th March 2017
03	Naval & Maritime Academy Trincomale	42	13th March 2017
04	Sir John Kotalawala Defense School - Rathmalana	10	03rd ,04th March 2017
05	Hewavitharana M.V - Rajagiriya	60	15th March 2017
06	Gonawala M.V - Ginigathhena	60	24th March 2017
07	University of Jafna	19	30th March 2017
08	Ocean University - Tangalle	12	21th March 2017
09	Ocean University - Tangalle	20	22nd April 2017
10	Naval & Maritime Academy Trincomalie	50	24th April 2017
11	Naval & Maritime Academy Trincomalie	30	20th June 2017
12	Faculty of Agriculture – University of Peradeniya	05	24th July 2017
13	Nursing Student – Colombo Nursing School	40	06th July 2017
14	Naval & Maritime Academy Trincomale	32	25th September 2016
15	Junior Naval Officers- NAVY Head Quarters, Colombo 01	14	16th,17th August 2017
16	DGS Educational Institute - Baduragoda	70	23rd August 2017

17	Naval & Maritime Academy Trincomale	34	11th October 2017
18	Junior Naval Officers- NAVY Head Quarters, Colombo 01	20	11th October 2017

Exhibition

No	Exhibition	Place	Date
01	"Thirasara Lanka National Exhibition – BMICH,Colombo	Colombo	2017/03/31- 04/04
02	I Gate Collage - Thalawatugoda	Colombo	2017/09/29
03	University of Kelaniya	Kelaniya	2017/10/02- 05
04	National Hospital	Colombo	2017/10/05
05	Seafood Festival	Colombo	2017/12/08-10

Media Activities

1. To provide information on the research activities of NARA through the electronic and print media.

2. Fish Forecasting Service News During Independent Television Network

3. Publish research papers and scientific articles in NARA's Research Offices, and publish every month in the island, Dinamina, Lankadeepa, Ceylon today, youth, Daily News, Thinakkural newspapers.

4. Preparing video programs on the results of the research

5. Updating and maintaining the Face Book account

6. Published "Sayuru Netha" Magazine

Awareness Program On Selected Schools About Aqua Club

2017.06.27	Anamaduwa C.C, Anamaduwa
2017.06.28	Ananda National School, Chilaw Dammissara Collage,Naththandiya Senanayaka Collage, Madampe
2017.06.30	Davisamara Vidyalaya, seeduwa Newsted Girls Collage, Negambo Harischandra National School, Negambo Dankotuwa Girls School, Dankotuwa

2017.07.03	Maliyadewa Boys School, Kurunegala Sir. John Kothalawala Collage, Kurunegala Kuliyapitiya C.C. Kuliyapitiya
2017.07.04	Bandaranayaka Vidyalaya, Gampaha Sangamiththa Girls Collage, Kiridiwela Weyangoda C.C. Weyangoda. Mahamaya Girls Collage, Kadawatha
2017.07.11	Gurukula Collage, Kelaniya Bomiriya National School, Kaduwela Darmapala Collage, Pannipitiya
2017.07.12	Takshila Collage, Horana Sri Sumahgala Boys School, Panadura Thissa Nationa School, kaluthara Kaluthara Girls National School, Kaluthara Kaluthara Vidyalaya, Kaluthara Bandaranayaka Vuidyalaya, payagala
2017.07.21	Ashoka Collage, Colombo 10 Nalanda Collage, Colombo 10 D.S. Senanayake Collage, Colombo 10 Visaka Vidyalaya, Colombo 07 Sirimavo Girls Collage, Colombo 07 Presbyterian Girls Collage, Dehiwala
2017.07.025	Kannangara Collage, Mathugama Ananda Collage, Elpitiya Darmashoka Collage, Ambalangoda Aluthagama Vidyalaya, Aluthgama
2017.07.26	Royal Collage, Colombo 07 Lumbini Collage, Colombo 05 Moratuwa Maha Vidyalaya, Moratuwa
2017.08.01	Mahinda Collage, Galle Southland Girls Collage, Galle Richmond Collage, Galle Sangamiththa Girls Collage, Galle Sujatha Girls Collage, Mathara

	St Thomas Girls Collage, Mathara St Sevres's Collage, Mathara Mathara C.C., Mathra
2017.08.02	Wijitha C.C., Dikwella Tsuchi National Collage. Hambanthota Debarawewa C.C. Thissamaharama Weeraketiya Rajapaksha C.C. ,Weeraketiya Mahanaga National School, Angunukolapalessa Thangalla Boys Collage, Tangalla Thangalla Girls Collage, Thangalla Thissamaharama M.V. Thissamaharama

Teacher's Training Program About Aqua Club For Aqua Club Coordinate Teachers

Date	District	Location	Program
2017/11/06-07	Puttalam Kurunegala	Nara Regional Research Center, Kalpitiya Navy Camp(Vijaya), Kalpitiya	Awareness program about aquatic sector and aqua club, Field visits, Practical trainings, life serving program with Navy
2017/11/09-10	Kaluthara Galle	Coastal Environment Center, Maduganga	Awareness program about aquatic sector and aqua club, Field visits, Practical trainings, life serving program with Navy
2017/11/14-15	Gampaha Colombo	Ocean University, Negambo Nara Regional Research Center, Kadolkele	Awareness program about aquatic sector and aqua club, Field visits, Practical trainings, life serving program with Navy

The Quiz Competition Held On 2017/12/08-09-10 Concurrent With The Colombo Sea Food Festival

- Selected 10th schools were participated for this competition.

1st place Moratuwa Maha Vidyalaya, Moratuwa

2nd place Visaka Vidyala, Colombo 07

3rd place Nalanda Collage, Colombo 10

Other Activities

- Providing media facilities for the NARA for the scientific sessions held in 2017 and providing media facilities for them.

- Provide auditory facilities to those who come to the Institute for NARA, other Institutes and Educational Visits.

- Organized ''Colombo Seafood Festival'' organization and media activities in Colombo

6. ANCILLARY SERVICES

6.1 PURCHASING & SUPPLY UNIT

Head Of The Divison : Mr.N.S.Hewagama

Introduction

The premier function of the division is to provide all necessary services and supplies in a formal and systematic manner in accordance with procurement guide lines in order to carry out research & development activities of divisions of National Aquatic Resources Research & Development Agency and Regional Research Centers.

Overview of the Division

Purchasing & Supply Division was established with effect from 23/05/2007.The functions and responsibilities of the unit are as follows.

- Supply goods and services relevant to the all divisions
- Handle all tender works
- Procurement works relevant to all divisions
- All insurance matters
- Prepared by payment voucher
- Air freight and clearance of goods
- Auction work relevant to disposal items
- Provide details to all divisions on their requirement

Performance

1. According proper tender procedures Mainly purchase of ongoing projects,
    - Purchase of Lab Equipment & Chemical Items
    - Purchase of all vehicle Parts
    - Purchase of all technical equipment & Accessories
    - Purchase of Stationery ,Furniture & other goods

The selection of supplies is use of supplier registration 2017 & rainbow –pages. Calling of tenders, Bid from local and foreign supplies for goods /equipments /Lab equipments/Chemicals following tender procedures as per the given specifications. Purchase of goods for day to day use by utilizing a petty cash Imprest and maintain records.

For the year 2017, the division has maintained about 106 Tenders following the tender procedures.

2. Clearance of goods received as donations, purchase of goods from foreign sources or airfreight of goods for repairs. Take actions where necessary to obtain tax relief when clearance of goods received from foreign sources are done & sending equipments for repair Etc: Abroad subject to normal mail & airfreight charges.

3. Insure all vehicles /motor- cycles/equipment of NARA through proper tender procures. Obtain insurance coverage for the personal perform duty at sea and land.

4. To provide a smooth service to the NARA ,the staff of the unit has been r

6.2 SERVICE AND OPERATION DIVISION

Head of the Division: Mr.S.K.S.Liyanaarachchi

Overview of the Year

Service &Operation Division (S&O) is asupportive division of the institution.S &O division provides and maintains all the services and develops the infra-structure facilities in line with work programs of the institution.

Activities

Service & Operation Division have several activities. They are categorized as follows.

- Rehabilitation of NARA main building& other Regional Centers.
- Installation and maintenance of air conditioners &electric/electronic appliances &maintenance of electrical distribution system.
- Landscaping Work.
- Repair & maintenance Work of Samuddrika Vessel.
- Repair & maintenance of vehicles.

For the year 2017, in addition to the day to day maintenance, below mentioned work has been completed.

01. REHABILITATION OF NARA MAIN BUILDING & OTHER REGIONAL CENTERS.

i. Upgrading and establish new Extension Unit office at main building first floor.
ii. Upgradingand establish new Internal Audit office at main building first floor.
iii. Upgrading DG's office by partitioning staff office & visitors area.
iv. Construction of Tide House in Mirissa fishery Harbor (temperature & tide well fixing)
v. Upgrading Finance Division office by Aluminium Partitioning.
vi. Renovations of sewer line of main building east toilet complex &rain water drainage lines.
vii. Renovation of Roof Main Building & IARAD Lab.
viii. Addition of new office area to NIOMSoffice.
ix. Extension work of Administration division office.
x. Renovation of quarters building
xi. Construction of Smoking Unit in Head office, Rekawa&Kalametiya.
xii. DG's office timber cladding work - ongoing
xiii. Upgrading of MBRD office - ongoing
xiv. Construction of SummerHut in Kadolkele research center.
xv. Construction of StockTank, Installed New water supply system in
xvi. Panapitiya Research Center.
xvii. Construction of Semi- closed out door shed in Kalpitiya Research

xviii. Center.

xix. Construction of Heat Insulation ceiling to Indoor Aquarium (IARAD)

xx. Fabricate GI roof forthe Outdoor Indigenous fish tank (IARAD).

xxi. Renovation of Quarters in Panapitiya Research Center.

xxii. Renovation of Lab & conference room at Rekawa Research center.

xxiii. Construction of Central laboratory complex at NARA- Consultant selected

02. INSTALLATION AND MAINTENANCE OF AIR CONDITIONERS &ELECTRIC/ELECTRONIC APPLIANCES

i. ESD Scientist' Rooms - 02nosof air conditioner Installation 3pase wiring Job completed.

ii. Internal Auditors& Government Auditors New Office - 03 nos Air conditioners Installation & Lighting Job completed.

iii. S&O New Office Area - New Lighting System Installed & Job completed

iv. Chairman's office Board Room - 02 nos Air conditioners Installation & New Wiring System With LED Panel system.

v. Upgrading existingPABX systemby replacing Fenton new PABX.

vi. IARAD culture room Lab racks lighting system installed &Job completed.

vii. Exention Unit - 02nos Air conditioner Installation 3pase wiring Job completed. Install LED Pannel System

viii. IPHTInternet wiring Installed & Job completed.

ix. Main Auditorium – 04 nos 3phs, 60000 BTU Air conditioner Wiring &Installtion Job completed.

x. Mini Auditorium New Lighting system installed.

xi. Finance Division – Electrical/ Telephone/ Internet Wiring & New lighting system installed.

xii. Main Building Ground Floor – LED lighting System Installed

xiii. IARAD LED lighting System Installed

xiv. ESD – Internet Wiring

xv. RRC /Kadolkele – 2 nosExtension line wired for main gate &Quarters

xvi. SED – AC installing & Wiring System

xvii. S&O - 04Nosair conditioner Installation & wiring job completed.

03. LANDSCAPING WORK

i. Carried out landscaping work atsurrounding area of NARA cafeteriaas to be elegance environment.
ii. Planting the coconut seeding of the NARA premises.
iii. Implemented National program ofnewly plantingGliricedia plants.
iv. LandscapedChairman's office area as to be elegance environment.

04. MAINTENANCE WORK OF SAMUDDRIKA VESSEL.

RV Samuddrika dry docked at Colombo dockyard PLC for the 5 year annual BV survey with hull renewal (painting), hull bottom, machineries, tail shaft survey and received the BV classification. Same time Dockyard attended to repairs of generators, main & auxiliary engines, cooling system and made deck layout modifications according to the BV classifications. Total repair, survey, & modification cost was Rs. 30 Mn.

After repairs at Dockyard, vessel sailed 495 hrs for the NARA research work.

05. REHABILITATION OF VEHICLES (10 NOS.)

There are 26 vehicles&17 Motor cycles in NARA fleet and 07out of fleet taken for rehabilitationduring the year. The vehicles undergone rehabilitations were.

Reg No.

- 61-6251
- 32-2951
- PB-8107
- PC-4035
- PA-5935
- NB-1486
- PB-7365

Addition to above Rs.8,897,074.68 spent for services, running repairs, license and insurance of the fleet during the year. 28 vehicles & 17Motor cycles effectively utilized for the running of 573,558.00 km during the year.

Cost for the Year Rs

For NARA Fleet

a) Rehabilitation of vehicles (From Capital Budget)	Rs. 4,666,441.91
b) Running repairs, Services cost Insurance & License fee (From recurrent Budget)	Rs. 4,230,632.77
c) Vehicle Monitoring System	Rs. 421,487.01
c) Vehicle Hiring charges	Rs. 0.00
e) Fuel Cost	Rs. 5,559,767.42
d) Total operated	573,558.00 km

* exclude Drivers salary, Overtime ,Bata and maintenance staff cost

NATIONAL AQUATIC RESOURCES RESEARCH AND DEVELOPMENT AGENCY
STATEMENT OF FINANCIAL POSITION AS AT DECEMBER 2017

	Notes	31.12.2017 Rs. Cts.	31.12.2016 Rs. Cts.
ASSETS			
CURRENT ASSETS			
CASH AND CASH EQUIVALENTS	1	67,244,465.08	57,627,248.00
TRADE AND OTHER RECEIVABLES	2	21,391,841.82	15,324,810.00
INVENTORIES	3	9,926,490.40	4,142,080.00
PREPAYMENTS	4	6,589,555.06	3,158,887.00
		105,152,352.36	80,253,025.00
NON-CURRENT ASSETS			
RECEIVABLES-DISTRESS LOAN	5	10,184,019.17	12,009,093.00
INFASTRUCTURE, PLANT AND EQUIPMENT	6	394,569,436.44	427,961,699.00
LAND AND BUILDINGS	6	3,667,981,304.04	3,698,405,808.00
CAPITAL WORK IN PROGRESS	7	9,134,757.12	5,250,764.00
		4,081,869,516.77	4,143,627,364.00
TOTAL ASSETS		4,187,021,869.13	4,223,880,389.00
LIABILITIES			
CURRENT LIABILITIES			
ACCOUNTS PAYABLES	8	57,257,558.40	47,918,938.00
ACCRUED EXPENSES	9	56,924,960.13	28,911,943.00
		114,182,518.53	76,830,881.00
NON-CURRENT LIABILITIES			
PROVISION FOR GRATUITY	10	106,873,600.50	91,089,383.00
		106,873,600.50	91,089,383.00
TOTAL LIABILITIES		221,056,119.03	167,920,264.00
NET ASSET		3,965,965,750.10	4,055,960,125.00
ACCUMULATED FUNDS	11	541,780,744.12	597,657,322.00
RESERVES	12	3,424,185,005.98	3,458,302,804.00
TOTAL EQUITY AND LIABILITIES		3,965,965,750.10	4,055,960,126.00

THE SIGNIFICANT ACCOUNTING POLICIES AND NOTES ANNEXED FORM AN INTEGRAL PART OF THESE FINANCIAL STATEMENTS.

N.S. HEWAGAMA
HEAD / FINANCE

APPROVED AND SIGNED ON BEHALF OF THE BOARD.

Dr. Anil Premarathne
CHAIRMAN

B.C.W. Iddamalgoda
DIRECTOR GENERAL

BOARD MEMBER

COLOMBO 28th March 2018

NATIONAL AQUATIC RESOURCES RESEARCH AND DEVELOPMENT AGENCY

PERFORMANCE STATEMENT FOR THE YEAR ENDED 31 ST DECEMBER 2017

	NOTE	2017 Rs. Cts.	2016 Rs. Cts.
REVENUE			
GOVERNMENT GRANT	13	420,993,659.35	377,584,429.00
OTHER INCOME	14	20,809,860.23	20,280,469.00
AMORTIZATION OF LOCAL & FOREIGN GRANT	15	125,802,918.53	113,552,414.00
TOTAL REVENUE		567,606,438.11	511,417,312.00
EXPENSES			
PERSONNEL EMOLUMENTS	16	278,110,523.58	252,454,602.00
TRAVELLING & SUBSISTENCE	17	298,070.30	326,069.00
SUPPLIES & CONSUMABLES USED	18	2,365,889.74	1,864,133.00
MAINTENANCE EXPENDITURE	19	20,132,729.98	15,049,621.00
CONTRACTUAL SERVICES	20	36,211,146.07	32,686,104.00
RESEARCH & DEVELOPMENT EXPENDITURE	21	118,828,659.35	86,853,429.00
DEPRECIATION & AMORTIZATION EXPENSES	22	125,802,918.53	113,552,414.00
OTHER OPERATING EXPENSES	23	20,090,944.48	5,406,773.00
TOTAL EXPENSES		501,840,882.03	508,193,145.00
SURPLUS (DEFICIT) FOR THE YEAR		(34,234,443.92)	3,224,167.00

THE SIGNIFICANT ACCOUNTING POLICIES AND NOTES ANNEXED FORM AN INTEGRAL PART OF THESE FINANCIAL STATEMENTS.

NATIONAL AQUATIC RESOURCES RESEARCH AND DEVELOPMENT AGENCY
CONSOLIDATED CASH FLOW STATEMENT FOR THE YEAR ENDED 31 ST DECEMBER 2017

	31.12.2017 Rs.	31.12.2016 Rs.
CASH FLOWS FROM OPERATING ACTIVITIES	(34,234,443.92)	3,224,167
SURPLUS(DEFICIT) FROMORDINARY ACTIVITIES		
ADJUSTMENT FOR :		
DEPRECIATION ON PROPERTY PLANT AND EQUIPMENT	125,802,918.50	108,604,655
AMORTIZATION OF DEFERRED EXPENDITURE	(125,802,918.50)	(113,552,414.00)
PROVISION FOR RETIRING GRATUITY	21,128,515	7,459,984
INTEREST ON STAFF LOANS	(802,656.31)	(641,889.00)
OPERATING PROFIT/(LOSS) BEFORE WORKING CAPITAL CHANGES	**(13,908,585.23)**	**5,094,503**
WORKING CAPITAL CHANGES		
(INCREASE) DECREASE IN INVENTORIES	(5,784,410.40)	(2,140,640.00)
(INCREASE) DECREASE IN TRADE & OTHER RECEIVABLES	(6,067,031.82)	(2,477,782.00)
(INCREASE) DECREASE IN PREPAYMENTS	(3,430,668.06)	79,266
INCREASE (DECREASE) IN ACCOUNTS PAYABLES	9,338,620.40	22,375,725
INCREASE (DECREASE) IN ACCRUED EXPENSES	28,013,017	(13,505,592.00)
CASH GENERATED FROM/ (USED IN) OPERATIONS	**22,069,527.25**	**9,425,480**
RETIRING GRATUITY PAID	(5,344,297.50)	(6,097,368.00)
NET CASH GENERATED FROM/ (USED IN) OPERATING ACTIVITIES	**16,725,229.75**	**3,328,112**
CASH FLAWS FROM INVESTING ACTIVITIES		
PURCHASE OF PROPERTY PLANT AND EUIPMENT	(70,342,795.73)	(71,352,741.00)
INVESTMENT IN DISTRESS LOAN	1,825,074	(2,912,368.00)
INVESTMENT ON WORKING PROGRESS	802,656.31	
INTEREST ON STAFF LOANS		641,889
NET CASH GENERATED FROM/ (USED IN) INVESTING ACTIVITIES	(50,989,835.84)	(73,623,220.00)
CASH FLAWS FROM FINANCING ACTIVITIES		
CAPITAL GRANTS RECEIVED	69,171,340.65	98,146,571
NET CASH GENERATED FROM/ (USED IN) FINANCING ACTIVITIES	**69,171,340.65**	**98,146,571**
NET INCREASE / (DECREASE) IN CASH AND CASH EQUIVALENTS DURING THE YEAR	9,617,217.08	27,851,463
CASH AND CASH EQUIVALENTS AT THE BEGINNING OF THE YEAR	57,627,248.00	29,775,785
CASH AND CASH EQUIVALENTS AT THE END OF THE YEAR	**67,244,465.08**	**57,627,248**
ANALYSIS OF CASH & CASH EQUIVALENTS AT THE END OF THE YEAR		
CASH AT BANK	67,244,465.08	57,627,248
	67,244,465.08	**57,627,248**

NATIONAL AQUATIC RESOURCES RESEARCH AND DEVELOPMENT AGENCY

STATEMENT OF CHANGES IN EQUITY FOR THE YEAR ENDED 31 ST DECEMBER 2017

	ACCUMULATED FUND				REVALUATION RESERVES	TOTAL
	GOVERNMENT CONTRIBUTION	FOREIGN GRANT	LOCAL GRANT	ACCUMULATED EXPENDITURE OVER INCOME		
BALANCE AS AT 1 ST JANUARY 2016	531,437,133.00	29,840,837	36,352,564.00	640,152,708.00)	4,095,231,343.00	4,052,709,169.00
FUNDS RECEIVED DURING THE YEAR	185,000,000.00	138,630	15,294,000.00			200,432,630.00
FUNDS UTILISED DURING THE YEAR	(87,430,286.00)	(15,870,879.00)	(10,251,249.00)			(113,552,414.00)
FUNDS TRANSFERS DUE TO REALLOCATION	(86,853,429.00)					(86,853,429.00)
NET SURPLUS/ (DEFICIT) FOR THE YEAR				3,224,167.00		3,224,167.00
BALANCE AS AT 01 ST JANUARY 2017	542,153,418.00	14,108,588	41,395,316.00	(636,811,893.10)	4,095,231,343.00	4,056,076,771.90
FUNDS RECEIVED DURING THE YEAR	188,000,000.00	472,650.00	282,350.00			
FUNDS UTILISED DURING THE YEAR	(106,954,863.15)	(8,639,762.89)	(10,208,292.49)			
FUNDS TRANSFERS DUE TO REALLOCATION	(118,828,659.35)					
NET SURPLUS/ (DEFICIT) FOR THE YEAR				(34,234,443.92)		
BALANCE AS AT 31 ST DECEMBER 2017	**504,369,895.50**	**5,941,475.11**	**31,469,373.51**	**(671,046,337.02)**	**4,095,231,343.00**	**3,965,965,750.10**

THE SIGNIFICANT ACCOUNTING POLICIES AND NOTES ANNEXED FORM AN INTEGRAL PART OF THESE FINANCIAL STATEMENTS.

ජාතික විගණන කාර්යාලය
தேசிய கணக்காய்வு அலுவலகம்
NATIONAL AUDIT OFFICE

මගේ අංකය
எனது இல.
My No. එස්ඵල්එස්/ජ්/නාරා/1/17/09

ඔබේ අංකය
உமது இல.
Your No.

දිනය
திகதி
Date 2018 දෙසැම්බර් 18 දින

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ජාතික ජලජ සම්පත් පර්යේෂණ හා සංවර්ධන නියෝජිතායතනය

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මාගේ සමාංක හා 2018 ඔක්තෝබර් 16 දිනැති ලිපියට යොමුවේ.

02. ඉහත සඳහන් ලිපිය සමඟ එවන ලද මාගේ වාර්තාවේ ඉංග්‍රීසි අනුවාදය මේ සමඟ එවා ඇත.

ඒ.ඒ.ඒ. ආනන්ද

නියෝජ්‍ය විගණකාධිපති

විගණකාධිපති වෙනුවට.

පිටපත් : 1. ලේකම් - ධීවර හා ජලජ සම්පත් හා ග්‍රාමීය ආර්ථිකය පිළිබඳ අමාත්‍යාංශය
2. ලේකම් - මුදල් හා ආර්ථික කටයුතු අමාත්‍යාංශය

අංක 306/72, පොල්දූව පාර, බත්තරමුල්ල. ශ්‍රී ලංකාව. இல. 306/72, பொல்துவ வீதி, பத்தரமுல்லை, இலங்கை. No. 306/72, Polduwa Road, Battaramulla, Sri Lanka.
+94 11 2 88 70 28 - 34 +94 11 2 88 72 23 ag@auditorgeneral.gov.lk www.auditorgeneral.gov.lk

ජාතික විගණන කාර්යාලය
தேசிய கணக்காய்வு அலுவலகம்
NATIONAL AUDIT OFFICE

මගේ අංකය
எனது இல.
My No. FLS/A/NARA/1/17/09

ඔබේ අංකය
உமது இல.
Your No.

දිනය
திகதி
Date 16 October 2018

The Chairman,

National Aquatic Resources Research and Development Agency.

Report of the Auditor General on the Financial Statements of the National Aquatic Resources Research and Development Agency for the year ended 31 December 2017 in terms of section 14 (2) (c) of the Finance Act , No.38 of 1971

The audit of financial statements of the National Aquatic Resources Research and Development Agency for the year ended 31 December 2017 comprising the statement of financial position as at 31 December 2017 and the statement of financial performance , statement of changes in equity and cash flow statement for the year then ended and a summary of significant accounting policies and other explanatory information , was carried out under my direction in pursuance of provisions in Article 154(1) of the Constitution of the Democratic Socialist Republic of Sri Lanka read in conjunction with Section 13(1) of the Finance Act, No.38 of 1971 and Section 32 (3) of the National Aquatic Resources Research and Development Agency Act , No.54 of 1981 amended by the National Aquatic Resources Research and Development Agency (Amendment) Act , No.32 of 1996 .My comments and observations which I consider should be published with the Annual Report of the Agency in terms of Section 14(2) (c) of the Finance Act appear in this report.

1.2 Management's Responsibility for the Financial Statements

The Management is responsible for the preparation and fair presentation of these financial statements in accordance with Sri Lanka Public Sector Accounting Standards and for such internal control as the management determines is necessary to enable the preparation of financial statements that are free from material misstatements, whether due to fraud or error.

අංක 306/72, පොල්දූව පාර, බත්තරමුල්ල, ශ්‍රී ලංකාව. இல. 306/72, பொல்துவ வீதி, பத்தரமுல்லை, இலங்கை. No. 306/72, Polduwa Road, Battaramulla, Sri Lanka.
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1.3 Auditor's Responsibility

My responsibility is to express an opinion on these financial statements based on my audit. I conducted my audit in accordance with Sri Lanka Auditing Standards consistent with International Auditing Standards of Supreme Audit Institutions (ISSAI 1000 1810).Those Standards require that I comply with ethical requirements and plan and perform the audit to obtain reasonable assurance about whether the financial statements are free from material misstatements.

An audit involves performing procedures to obtain audit evidence about the amounts and disclosures in the financial statements. The procedures selected depend on the auditor's judgment, including the assessment of the risks of material misstatement of the financial statements, whether due to fraud or error. In making those risk assessments , the auditor considers internal control relevant to the Agency's preparation and fair presentation of the financial statements in order to design audit procedures that are appropriate in the circumstances , but not for the purpose of expressing an opinion on the effectiveness of the Agency's internal control. An audit also includes evaluating the appropriateness of accounting policies used and the reasonableness of accounting estimates made by management, as well as evaluating the overall presentation of financial statements. Sub – sections (3) and (4) of Section 13 of the Finance Act , No.38 of 1971 , give discretionary powers to the Auditor General to determine the scope and extent of the audit.

I believe that the audit evidence I have obtained is sufficient and appropriate to provide a basis for my audit opinion.

1.4 Basis for Qualified Opinion

My opinion is qualified based on the matters described in paragraph 2.2 of this report.

2. Financial Statements

2.1 Qualified Opinion

In my opinion, except for the effects of the matters described in paragraph 2.2 of this report the financial statements give a true and fair view of the financial position of the National Aquatic Resources Research and Development Agency as at 31 December 2017 and its financial performance and cash flows for the year then ended in accordance with Sri Lanka Public Sector Accounting Standards.

2.2 Comments of financial Statements

2.2.1 Sri Lanka Public Sector Accounting Standards

(a) Sri Lanka Public Sector Accounting Standards 01

Although Assets and Liabilities can't be setoff, in accordance with the paragraph 48 of the Standard,Rs.3,278,097 value of debit balances has been set off against Creditors balance and shown as Rs.50,240,155 after offsetting .

(b) Sri Lanka public sector Accounting Standards 02

(i) In accordance with paragraph 25 of the standard Rs.372,865 value of working progress was not included under the Investment Activity in the Cash Flow Statement.

(ii) Although Net Cash Flows from operating activities in cash flow statement had been shown as Rs. 8,160,942, , that amount should be Rs. 2,816,645 as per correct calculations, hence the net cash flow from operating activities has increased by Rs.5,344,297.

(iii) Although property, plant and equipment under purchasing activities were shown as Rs. 70,342,795 under Investing activities of the Cash Flow Statement, in ledger

accounts verification it was observed that the cash payment made for the year under review for the purchase of such assets was Rs. 42,063,057.

2.2.2 Accounting Deficiencies

The following Observations are made.

(a) Rs 6,002,443 of Chemical material stock issued for research during the year under review, has been debited to the final stock instead of being identified as an expense of the year, hence the final stock value exceeded by Rs. 6,002,443 and the Chemical consumption expense value was below that value.

(b) Rs. 79,568 of depreciation value has not been reflected in the year 2017 relevant to Rs. 810,000 of capital grant received as equipment in the year 2016 and Rs. 119,000 of computers, hence Non-current Assets and capital grant value exceeded by that amount.

(c) The revaluation expenditure of Rs. 5,406,380 spent on repairs of buildings and automobiles during the year under review has been debited to buildings motor vehicles accounts as capital expenditure.

(d) Though Rs. 2,056,756 advance payment has been recommended to pay for the institution that provided consultancy services for the construction of a new laboratory complex with tax at the end of the year , while the accrual expenses are only accounted for sum of Rs.1,843915, hence Creditors and the work in progress understated by Rs. 212,841 each.

(e)Rs,469,340 amount of insurance claims receipts had been credited to the motor vehicle account during the year under review. As a result the motor vehicle value in the financial statements was below Rs.469,340, while the deficit was in excess of that value.

(f) 30 percent loyalty income of Rs.506,253 which is receivable for providing consultancy services by NARA Institute for research projects, has been accounted as liability under incentive payment on consultancy income distributable profit, instead of accounting as income

2.2.3 Non-Evidence for Audit.

The accrual expenses incurred for more than two years amounted to Rs. 5,574,590 and did not provide any supporting documents such as invoices and balance certificates to verify the values.

2.3 Accounts payable and payable

The following observations are made.

(a) Actions had not been taken to recovered a sum of Rs.1,612,898 from an external institution for the preparation of feasibility study report in respect of development of six fisheries harbors for more than 04 years.

(b) The Agency had been unable to recover a sum of Rs.239,550 due for employees who released to the Presidential Secretariat during the year 2013.

(c) An amount of Rs. 404,010 had been paid as an advance to an outside institution in 2010 for the establishment of a software system. Though the software has not been installed even at the end of the year under review, actions had not been taken to recover that amount.

(d) An amount of Rs.125,900 postgraduate course fees which had been paid to two employees as a loan by the institution receivable from three years.

(e) Even though Rs 3,174,489 has been shown in financial statement as an amount payable to Ceylon Fisheries Harbour Corporation for supply of security service , that amount should be Rs.6481,007 receivable for security service to NARA as per information of Ceylon Fisheries Harbour Corporation, .

2.4. Non-compliance with laws, Rules, regulations and management decisions

Instances of non- compliance with the following laws, rules, regulations etc, were observed.

Rules, Regulations and Management decisions.	Non-compliance
(a) National Aquatic Resources Research and Development Agency Act No 54 of 1981	
(i) Section 17 of the Act	No scientific and management committees have been established in accordance with the provisions of the Act, as it has not been possible to carry out instructions and recommendations on the subject of scientific and technical matters to be submitted to the Committee on the acceptance, evaluation and approval of approved projects.
(ii) Section 34 of the Act	A register, trial and other investigations conducted by the Agency, and a register containing data, reports and details obtained with regard to inquiries and findings, should be maintained by the Director-General, but such a document has not been maintained

(b) Financial Regulations of the Democratic Socialist Republic of Sri Lanka

(i)Financial Regulations 104	Although Rs.52,000 cost of Computer which included the software purchased for Rs. 411,000 in year 2009, has been missed in the year 2012, No action has been taken in accordance with the financial Regulations.
(ii)Financial Regulations 387 and 395	Bank reconciliation statements were not prepared during the year under review for 03 bank accounts and there was an overdraft balance of Rs.4,352 at one bank account.
(iii)Financial Regulations 757 (2)	The board of survey reports for the year under review had not been submitted for audit.
Treasury Circular No. 842 of 19 December 1978 and Financial Regulations 502 (2)	Fixed assets register had not been maintained.
Treasury circular No: IAI / 2002/02 dated 28 November 2002	A fixed assets register had not been maintained for computers, devices and software.

3. Financial Review

3.1 Financial results

According to the Financial statements presented financial result of the Agency during the year under review was a deficit of Rs. 34,234,444 compared to with, surplus of ,

Rs.3,224,167 for the previous year, the deficit for the year under review declined by Rs.37,458,611. Employee remuneration, research and development expenditure and other operating expenses were increased by Rs. 25,655,921, Rs. 31,975,230 andRs. 14,684.171, respectively, despite the government grants increased by Rs.43, 409,230 during the year under review.

Although there was a deficit from 2012 to 2015 in analyzing financial result of six proceeding years, there was a surplus in the year 2016. In 2017 deficit had been arrived again. In the year 2012, the contribution of Rs.123,494,212 continued to increase to Rs. 369,231,183 and Rs. 369,678,999 respectively in 2016 and 2017 respectively due to the readjustment of non-current asset's depreciation and employee remuneration to the financial results.

4. Operational review

4.1 Performance

(a) Although the objective of the National Aquatic Resources Research and Development Agency Act No. 54 of 1981 is to provide guidance and expertise for identifying aquatic resources, valuation, management and development, promoting research and coordinating the activities of the institutions involved ,Research Instructions had not been issued regarding promotion of fish crops in fresh water tanks and post promotion of fish harvest.

(b) In reviewing the action plan and progress reports in the year under review , Rs230 Million had been allocated for 74 research projects and Rs. 108.29 million cost had been incurred for implementation of 68 projects. The physical progress of implementation of the projects ranged from 24 to 98 per cent, and the following weaknesses were observed in 14 out of the 68 projects audited.

(i) Rs.1,440,000 has been made for the year 2010 for the creation of environmentally friendly and resource friendly new style generating machines for gathering fishing rods and radio boya and catch skip jack tuna in deep sea. 03 fish gathering gutters had been created incurring cost of Rs. 1,412,535. One of them was installed on Kaluthunai on 29 September 2016 and the remaining gutters were kept as idle by July 2018.

(ii) In the Hambantota district Rs.1,130,000 was provided for ornamental fish cultivation and disease management during the last year. Rs. 1,223,300 had been spent for this purpose. The fish had to be deposited in the ponds during the March of the year, but it had begun on July 28 and the project had failed due to the lack of water in reservoirs. There was also insufficient attention to the management of disease and no sufficient follow up actions had been carried out.

(iii)The research project for the development of fish feed for seabass fish cultivation in the lagoon floating net cages is scheduled to commence in 2015 and at the end of the year 2017, Rs.2,231,174 had been spent for this purpose. The 12 net cages in the Negombo lagoon had been set up by the end of 2016, but the acquisition of the relevant fingerlings delayed to June 2017.27 number of net cages in Puttalam lagoon which needed to cover the research project , failed to setup until the end of the year 2017. The supply of seabass fingerlings for net cages in puttalam lagoon was delayed from 2017 to June 2018. Although there are improvements in the organic seabass fish feed formulations, the research has shown that despite the fact that it has taken 2 ½ years for the purpose of quantitative testing for the final review of fish feed formulations, the objective of the experimental study and the improved food composition for the practical use of fish breeding fish, The goal was not reached.

(iv)Rs. 2,286,197 has been spent during the year under review for the Sri Lanka's Small pelagic and Large pelagic Fish Breed Assessment and Management Research Project. Though The project is primarily driven to data updating and analyzing regarding to small sea fishing and a large sea fishing harvest in the year Assessment of large sea fish resources and small sea fish resources in Sri Lanka

has not been carried out and there is no mechanism of providing important observation to fisherman engaged in of small and large sea marine fishing.

(v) Though Rs. 710,000 has been allocated for Improvement of software package for providing services to customers by online system, via The Fisheries Information Center no activities has been initiated for software upgrading and customer service even as at 31 December 2017.

(vi) Following observations were made in reviewing physical progress of nautical map creating.

- Although it was planned to carry out water surveying of 4756 square kilometers in the coastal area of 900 sq. Km in the shallow sea area under nautical mapping development in 2017 on the purview of the Colombo - WeligamaNaval Shipyard, only 410 sq. Km of shallow water surveys had been carried out on the shallow waters only at the end of the year Deep sea surveys did not take place.
- Although it was planned to complete water measurements of 21,410 square kilometers out of the total area of 30,000 square kilometers in the year under review of the total nautical chart in Trincomalee up to Point Pedro, only 6,425 square meters had been measured at the end of the year.
- Although it was planned to create a marine map for the Kalpitiya lagoon during the year, none of the water measurements carried out in the year 2017 had been accomplished.

(vii) Rs. 3,186,196 had been spent at the end of the year 2017 for the existing and scientifically improved multi-day fishing vessels and the Post Harvestmen Damage Assessment at Peliyagoda Central Fish Market. To investigate the post-harvest damage in the physical performance of this, in the year 2016, the research had been carried out and the post-harvest loss was estimated to be 40 per cent. The research project was carried out with the following objectives during the year under review.

- Introduce an efficient radiant system for existing and new multi-day boats.
- Assessment of fishery damage in existing multi day vessels and improved multi-day fishing vessels.

- Consultancy report on creation of multi-day boats with refrigeration system has obtained from Moratuwa University with the payment of Rs.950,130 in the year 2017. However, there was no research to ensure the technical and financial fitness of the refrigeration system mentioned in that consultation report. Due to this Agency failed to achieve the objective of creating effective refrigeration systems for multi-day boats during the year under review. Further, the evaluation of the fishery damage in the existing and the improved fishing vessels was a prime objective of this research, but due to the impossibility of introducing multi-day vessels with a refrigeration system, this objective was not achieved. There was no emphasis on research on minimizing post-harvest damage.

(viii) Rs. 14,500,000 has been allocated for the year under review with the assistance of Norway with an independent survey for assessing the fisheries resources of Sri Lanka. , only 2,111,621 had been spent by the 31st December 2017. Accordingly, it was observed that Rs.12,383,379 had been overcharged. Furthermore, detailed action plans and detailed budget forecasts were not prepared for this project.

(ix) Rs.1,362,371 and Rs. 1,955,463 had been spent during the year under review for the change of the space of the heavy metal particles in the selected large marine fish, the change of the space of the particles and the toxic and nutritive monitoring of the bivalvemolluscsin the large marine fish. However, the performance reports relevant to these projects were not submitted.

(x) The research work on the research around the Sri Lankan coastal land around the Mineral Deposits combinations was abundant due to the suspension of the research officer's service involved in the said research work and no proper replacement of another suitable research officer. For this purpose, only Rs.180,242 has been used equaling to 56 per cent from the revised estimate of Rs.320,700.

(xi) Rs. 790,794 had been spent in the year under review for the establishment of the sea observation Center and the Sea Level monitoring Center. Despite the initial objective of setting up these centers to provide technical assistance to the relevant agencies on marine warnings , providing technical assistance via this center was halted from February 2017.

(xii) Rs. 159,042 had been spent for the Kadolkale park management program in Negambo scheduled to be implemented in the year 2017 by the internal Aquatic Resources and Aquaculture Development division. Even though this project includes The construction of three name boards and a cafeteria, installation of a toilet system and preparation of lanes, the construction of the cafeteria, soil filled and lane processing including several activities had not been completed.

(xiii) Rs. 1 million had been allocated for the development of a Marine Database which was a project to be implemented in 2017 by the National Marine and Marine Science Division and Rs.153,171 has been spent. The development of a marine data system was not completed in 2017, and only 15 per cent financial utilization was exists.

4.2 Management activities

The agency's lands worth of Rs.53,400,900 located at the Kalpitiya Research Station, Kapparotota Nara Regional Center and Rekhwa Regional Center were not taken over by the agency.

4.3 Transactions on Contentious Nature

Out of the objectives of the agency, Rs. 15,245,000 was spent on the sale of the fish stalls at Beruwala which were ineffective without being used for any purpose from March 2014. Further, the land for these constructions had not been properly taken over to the agency.

4 .4 Idle and underutilized Assets

The following observations are made.

(a) The ThandooriBurner of Rs.120,000 and the plate washing machine of Rs.352,800 purchased for canteen and the Aluminum Ladder purchased valued at Rs.100,000 had remained idle without using from the year 2011 up to 31 July 2018, the date of Audit.

(b) A computer software purchased for Rs.76,800 in April 2014 had not been made use of up to September 2018 the date of audit

(c) Rs. 675 in 2002 on three bank accounts maintained at regional offices and Rs. 97,768 in a bank account were inactive since 2015.

4.5 Uneconomic Transaction

Even though Rs. 4,493,052 has been spent for the purchase of two engine boats for the production of 02 boats and Rs 2, 902,938 cost incurred for the production of 02 boats. the production had been stopped halfway.

4.6Commencement of projects on lands not properly vested

The Agency had carried out construction by spending Rs.552,906 in the preceding year without vesting the ownership of land located at Panapitiya area belonging to the National Aquaculture Development Authority , even the ownership of the land had not been vested at the end of the year under review.

4.7 Resource of the Agency given to other public institutions

The Agency hadreleased 06 officers to the Line Ministry and other government institutions and paid a sum of Rs.2,125,777 to those officers as salaries and allowances in the year under review.

4.8 Staff Administration

The following observations are made

(a) The two senior level post in the Administration division, the Director (Administration and Human Resources) and the Assistant Director (Administration) were vacant from 30th April 2016 and actions has not been taken to fill the said post until July 25 2018.

(b) By the 31 December 2017, there were 95 vacancies in 27 posts directly related to research. It was observed that the continuation of vacancies in these positions would adversely affect the key objectives of the Agency. Moreover, on 31st December 2017, there were 42 vacancies on 25 supporting posts.

5.Sustainable development

5.1 Achievement sustainable development Goals

The questionnaire has stated that each State Institution should act on the basis of the United Nations " Agenda for Sustainable Development in the year 2030 " and the questionnaire states that the National Aquatic Resources Research and Development Agency (NARA) has been involved in matters relating to the year under review.However, actions had not identified the targets for achieving the development goals, targets and targets for achieving the targets and indicators on how to achieve targets.

6. Accountability and Good governance

6.1 Presentation of financial statements

Even though the financial statements should be presented to audit within 60 days after closure of the financial year in terms of section 6.5.1 of the Public Enterprises Circular , No.PED/12 dated 02 June 2003 , the Agency had presented financial statements for the

year under the review to audit after a delay of 49 days that is on 18 April 2018.Further the Draft Annual Report which should be presented along with the financial statements had not been presented.

6.2 Internal Audit

The following observations are made.

(a) The internal auditing of the Agency had issued 21 internal reports in the year under review, out of which only 05 reports had been answered. The response had not been included in the corrective actions taken in the observations in the internal audit reports.

(b) The Agency's Internal Audit scope, procurement process, system controls, general ledger and monthly accounts, loans and advances, research project progress and a limited internal auditing staff were confined to four officers, including the Chief Internal Auditor.

6.3 Audit Committees

In the year under review, only 3 meetings of the Audit & Management Committee were held.

6.4 Unresolved Audit paragraphs

The " Tharanee " vessel constructed by spending Rs.15,685,632 in the year 2012 for the research activities of coastal Zone had not been used for the relevant purpose up to end of the year under review. Even though directives had been given at the committee on Public Enterprises held on 12 November 2014 that action should be taken to sell the relevant ship, It had not been sold even by 31 December 2017. However , a cost of Rs.9,758,290 had been spent from the date in which this vessel had been constructed up to the end of the year under review for salaries, overtime and security purposes of the vessel security officers who was engaged in the activities of the vessel.

6.5 Procurement and contract process

6.5.1 Procurement

Following observations were made regarding the Contract for the establishment of the Naval Research Building

I. Upon approval of the Procurement Committee decisions of the Ministry of Ports and Highways, the approval of the Procurement Committee on ICTAD registration was received on November 02, 2017, to call for bids from contractors, but only two committee members were participated.

II. In The contract awarded to the Institute of Creative Arts , the contract period had been specified and as to the contract agreement with the private institute 63 days has been allowed to complete the repair work. However, the final bills of the contract had been submitted in May 2018 and had a delay of 2 ½ months over the expected period.

III. It was observed that the Agency is expected to complete the air conditioning and internal electrical systems of the building by their own which already incurred Rs.5,519,645 cost for other renovation activities .Eventhough It took almost a year to complete the repair work for the period from July 2017 to June 2018, and no repairs had been completed to the extent possible until 19th September 2018.

IV. Although, the contract packaging should be used as a method of procurement which can be achieved economy and efficiency, as per procurement guidelines 4.1, it was observed that the benefits of the contract package did not materialize.

7. Systems and Controls

Deficiencies in systems and controls observed during the course of audit were brought to the attention of the Chairman of the Agency from time to time .Special attention is needed in respect of the following areas of control.

Areas of systems and controls	Observations
(a) Internal Audit	- Sufficient Internal Audit had not been conducted and adequate staff had not been attached.
(b) Staff Administration	-Actions had not been taken to fill vacancies.
(c) Board of Survey	-Delay in conducting annual board of survey.
(d) Debtors	-Balance confirmations has not been furnished as at 31 December 2017.
(e) Operational Control	-Failure in planning for required surveys , research and giving instructions by identifying issues of the institution which are connected to Fishery Industry and established to development of Fishing community and promotion. -Not having an adequate programme for promotion of the conducted researches among fishing community , development of those researches, properly giving instruction thereon. -Failure in conducting required researches regarding testing timely water in Inland water reservoirs and promotion of Inland water fish farming. -Failure in conducting surveys in regarding Inland water fish harvest. -Failure in collecting data relating to the researches and acting as an information center.

-Opportunity has not been given for using research reports to the interested parties.

(f) Accounting System Control

-Duties of entering payment vouchers, receipts and journal vouchers to the accounting system and certification and entering to the ledger has been assigned to the same officer of the Agency

-Financial Director, who is a senior officer in the financial division is not acting as an administrator of the accounting system.

-Without any prior knowledge of the Chief Financial Officer, the accounting system has been able to modify data, deletes data and include false data.

-Not having facilitated the Agency's internal auditor and government audit officers to access the accounting system.

-Access to the general ledger and access to the Trial Balance is complicated due to the unwanted account creation in the accounting ledger's general ledger.

-Due to the lack of coding of ledger accounts in the accounting system, comparison and examination of the Trial balance and ledger accounts have become very complicated.

-Not using the accounting system in such a way that budgetary control can be maintained comparing the actual costs to the annual budget for a specific day.

Sgd./ H.M. GAMINI WIJESINGHE
Auditor General

H.M.Gamini Wijesinghe
Auditor General

Report of the Auditor General on the Financial statement of the National Aquatic Resources Research & Development Agency for the year ended 31st December 2017 in terms of section 14(2) (c) of the finance Act, No:38 of 1971

2.2. Comments of the financial statement

2.2.1 Sri Lanka Public Sector accounting standards.

(a) Sri Lanka Public Sector accounting standard No: 01

Debtors & Creditors will be considered individually hereafter.

(b) (i) Being Rectified.

(ii)This situation will be controlled.

(iii) This situation will be controlled.

2.2.2 Defects of accounting system.

(a) Proper board of survey report will be submitted to the auditor General.

(b) Actions have been taken to prevent this situation.

(c) Actions have been taken to prevent this situation.

(d) Actions have been taken to prevent this situation.

(e) Actions have been taken to prevent this situation.

(f) Actions have been taken to prevent this situation.

2.2.3. Unexplained changes

Payable amount Rs.3, 174, 489.00

2.2.4 No sufficient evidence for auditing

Instructions were given to provide evidence attached to the journals.

2.3

(a) Being taken legal actions.

(b)Discussions were done to recover the receivables.

(c) This system has been installed. Because of the incompatibility with the main system it is not been used.

(d)Recovered in 2018

2.4 Non compliance with laus , Rules Regulations and Management decision

(b) (ii) Relevant bank reconciliations are being prepared.

(iii)Action will be taken to rectify the defects.

(c) Treasury Circulars

(i) Fixed assets registers have been prepared for building, vehicle and land. Others will be prepared hereafter.

(ii) Being prepared.

4.4 Idle and underutilized assets

(a) Proper actions will be taken to dispose the scraps.

(b) Proper actions will be taken to dispose the scraps.

(c) Proper actions will be taken to close these accounts.

6. Accountability and Good governance

Final accounts of 2018 will be submitted on time.

6.5 Procurement

6.5.1 All signatures have been taken.

6.5.2 Action has been taken to prevent this type of errors.

6.5.3 Actions will be taken to avoid these type of occurrences.

7. System Control

(c)Delay in conducting annual board of survey

Actions will be taken to conduct the annual board of survey (2018) on schedule.

(d) Actions will be taken to conduct the annual board of survey (2018) on schedule.

(e) Actions taken to omit the shortcomings after the discussions with the suppliers as well.

N.S.Hewagama

Director Finance

B C W Iddamalgoda

Director General

** This is a translation of a Sinhala copy.