National Aquatic Resources Research

and

Development Agency

Scientific Sessions - 2017

"Diversification of Aquatic Industry for Development"

27th July 2017

National Aquatic Resources Research and Development Agency (NARA)

Colombo15

Sri Lanka

Organizing Committee:

Mr. A.B.A.K. Gunaratne

Dr. H.M.P. Kithsiri

Dr. K. Arulananthan

Mr. S.U.P. Jinadasa

Mr. M.M.A.S. Maheepala

Ms. D.D.D. Weragodatenna

Mr. B.K.K.K. Jinadasa

Ms. D.R. Herath

Mr. H.D. Wimalasena

Ms. B.G.S. Kariyawasam

Dr. R.P.P.K. Jayasinghe

Dr. Niroshan Wickraarachchi

Mr. Ananda Athukorala

Mr. B. Tharanga

Edited by:

Dr. H.B. Jayasiri

Cover designed by:

Mr. Anuruddha Ratnayake

Contact :

Telephone: 0 11- 2521000/2521006

Fax: 011-2521932

Email: postmaster@nara.ac.lk

Web: www.nara.ac.lk

Content **Page No**

Content **Page No**

Content **Page No**

Content **Page No**

Content **Page No**

Fisheries, Aquaculture, Biotechnology and Animal Health

Seasonal variation of the distribution and abundance of blue whales (*Balaenoptera musculus*) in two sensitive habitats in Sri Lanka

U.S.P.K. Liyanage[1,2*], P.B. Terney P Kumara[1], K. Arulanandan[2] and Marianne Rasmussen[3]

[1]*Faculty of Fisheries and Marine Sciences & Technology, University of Ruhuna, Matara, Sri Lanka*

[2]*National Aquatic Resources Research and Development Agency, Crow Island, Colombo 15, Sri Lanka*

[3]*University of Iceland, Field Research Centre, Hafnarstétt 3, 640 Húsavík, Iceland*

Coastal waters of Sri Lanka have been identified as one of the blue whale (*Balaenoptera musculus*) hot spots in the world. The high abundance and distribution of the blue whales were recorded in the southern tip of Sri Lanka, where they aggregate for feeding just by one of the busiest shipping lanes connecting East and West, causing a heavy annual mortality rate. In order to conserve this natural wonder, a properly planned management and conservation programme has been identified as an utmost importance. To facilitate that, basic knowledge on the distribution, abundance, population size, seasonality, and the environmental parameters influencing the above factors are very essential. Two 230 km long dedicated visual transect surveys were completed for the Southwest (Tangalle to Galle) coastal region (2015 Inter-monsoon - 2016 Southwest monsoon) and one survey for East coastal region from Pulmudei to Sampur (2016 Northeast monsoon) covering 2400 km^2. Eight conductivity, temperature, depth profiles were done along the mid points of each transect line with a 10 km distance in between. The thermocline of both seasons of the Southwest and Northeast coasts lies between 70-80 m (23-24 ^{0}C) and below 120 m respectively. The highest chlorophyll-*a* range, 1-2 mg/l above thermocline revealed the depth of the highest primary productivity in this area. The highest number of blue whale sightings during both Southwest monsoon and Inter-monsoon period was recorded close to the continental shelf, off Mirissa area exactly on the dense shipping lane, while in Northeast coast, it was observed close to the Mahaweli river mouth during Northeast monsoon. Average blue whale density of the Southwest coast is 0.024 indivi. km^{-2} which is smaller than 0.0670 indivi. km^{-2}, that of Northeast coast. But the highest blue whale mortalities were observed in the Southwest coast.

Keywords: abundance, blue whale, *Balaenoptera musculus*, distribution, thermocline

**Corresponding author – email :upulliyanage@hotmail.com*

Effects of the extruder die temperature on some physical properties of extruded fish feed pellets containing wheat flour and corn flour as starch sources

M. Epasinghe*, G.S.C. Perera, H.M.P. Kithsiri, V. Pahalawattarachchi, A.M.A.N. Adikari, T.A.D.W. Karunaratne and K.L.W.T. Maduaka

National Aquatic Resources Research and Development Agency (NARA), Crow Island, Colombo 15, Sri Lanka

Extruding process is a very complicated process where product quality is highly variable depending on the type of extruder, screw speed, and configuration, temperature profile on the barrel, die profile, feed rate, and feed moisture. The objective of this research was to evaluate the effect of the extruder die temperature on moisture content (MC), expansion ratio (ER), floatability (F) and bulk density (BD) of the extrudates. Finely ground fish meal (CP 60 %, Maldive product) 22 %, plant protein sources (CP 84 %) 17 %, de-fatted soya (CP 47 %) 10 %, shrimp head 7.5 %, rice bran 14 %, wheat flour 17.5 %, corn flour 7.5 %, vitamin and mineral 2.0 %, dicalcium phosphate 0.5 % and fish oil 2.0 % were mixed while adding water to achieve targeted moisture of 400 g/kg wet basis using a dough mixer. Approximately 5 kg sample of each replicate was extruded in duplicates (n= 6) using a single–screw extruder. The barrel temperature was set at 100 °C, 120 °C and 140 °C while the same die temperatures were tested as three treatments during this study. Data collected from the study were analyzed using one-way ANOVA while Tukey's HSD test was performed to examine the significant differences at P= 0.05. The highest F (80 %), ER (1.13) and lowest BD (412.00 g/L) as well as the lowest MC (5.74 %) values were noted in pellets that were extruded at the die temperature of 120 °C. Increasing die temperature from 120 °C to 140 °C, F and ER values were significantly decreased by 12.50 and 9.73 % respectively. Similarly, BD and MC values were significantly increased to 9.17 and 4.88 % respectively. The results of this study elucidated negative effect of increased die temperature higher than 120 °C on the physical properties of the extruded pellets. Moreover, it is recommended to use a single screw extruder at 120 ˚C as suitable die temperature and moisture level of 400 g/kg, for producing floating pellets in diets containing wheat flour and corn flour as starch sources.

Keywords: bulk density, die temperature, expansion ratio, floatability, moisture content

*Corresponding author – email :edmepasinghe@gmail.com

Comparison of nutrient levels of fish meal prepared from scavenger fish species (Genus: *Pterygoplichthys*) with locally produced commercial fish meal

R. Weerasingha* and D.A. Athukorala

National Aquatic Resources Research and Development Agency (NARA), Crow Island, Colombo 15, Sri Lanka

Scavenger fish, popularly known as tank cleaner (TC), generally called sailfin or sucker mouth catfish has been a very serious threat to inland water bodies and its fishery during the last decade. A mixed population of *Pterygoplichthys pardalis* and *P. disjunctivus* are reported in water bodies of Sri Lanka. Recently, more attention has been paid to utilize this noxious species for edible product development and as fish feeds. Present research intended to analyze nutritional value of prepared scavenger fish meal (TCFM) and compared it with a locally produced fish meal (Agri-star®) (LFM). Scavenger fish, which is enough to run the Agri-star fish meal plant at Peliyagoda, were collected from fishermen of Kalawewa. After ice packaging, 300 kg of TC were transported to Peliyagoda fish meal plant and fish meal was prepared. Proximate composition, some essential minerals, amino acid and fatty acid profiles were analyzed and compared with the commercial fish meal. The protein content of TCFM was more or less similar to that of LFM. Ash content of TCFM is significantly *(P<0.05; LSD)* lower than that of LFM. Total lipid content of TCFM is significantly *(P<0.05; LSD)* higher than that of LFM. The values of oleic acid and docosahexaenoic acid (DHA) of TCFM and LFM was 15.05, 12.88 % and; 1.14, 5.32 % respectively. In comparison of ten essential amino acids of fish, TCFM and LFM contain methionine, 11.37, 0.36 µg/g; tryptophan, 0.78, 0.75 µg/g; isoleucine, 6.56, 0.32 µg/g; and leucine, 38.56, 0.98 µg/g respectively. Threonine and phenylalanine were only recorded in TCFM as 0.18 and 12.82 µg/g respectively. Nevertheless, arginine, 0.16 µg/g; lysine, 9.26 µg/g; and valine, 3.64 µg/g were reported only in LFM. High levels of methionine, isoleucine, leucine, phenylalanine, proline, aspartic acid, glutamic acid, glutamine, and tyrosine were reported in TCFM. The study revealed that scavenger fish meal could be utilized to reduce the pressure of local fish meals as a partial protein replacement and essential fatty acid supplement. But the cost of production of both fish meals is similar. Limiting effect of lysine can be minimized by adding L-lysine to the diet with scavenger fish meal.

Keywords: invasive fish species, lysine, nutritional value, scavenger fish meal

*Corresponding author – email :rochanaweerasingha@gmail.com

Biological and molecular analysis of bullet tuna, *Auxis rochei* from Southern, Western and North-western coasts of Sri Lanka

D.R. Herath[1,2]*, A.A.D.G.U. Amarakoon[1], J.A.C. Prasad[1], H.A.C.C. Perera[1] and G.H.C.M. Hettiarachchi[2]

[1]*National Aquatic Resources Research and Development Agency (NARA), Crow Island, Colombo 15, Sri Lanka*

[2]*Department of Chemistry, Faculty of Science, University of Colombo, Colombo 3*

Neritic tuna and tuna-like species are economically very important as food fish in Sri Lanka. Bullet tuna, *Auxis rochei*, is one of the 5 species of neritic tuna caught in Sri Lankan waters. The bullet tuna catch contributes about 40% to the total neritic tuna catch of Sri Lanka. This study was undertaken as little information is available on the biological and molecular aspects of bullet tuna of Sri Lanka. Eighty-two (82) bullet tuna fish (62 females and 20 males) samples were collected from Chilaw, Negombo, Beruwela, Dodanduwa, Galle and Weligama during the period of May 2016 to April 2017. The length weight (L-W) relationship was $W=0.004\ L^{3.4}$ for the samples collected. This suggests a healthy growth in their natural environment. The stomach content analysis revealed that *A. rochei* are non-selective feeders, feeding on any prey item available in the surrounding waters. The major prey item was seen to be fish (44.8%), followed by the combination of fish and shrimp (27.6%), shrimp (24.1%) and the combination of shrimp and cephalopod (3.5%). The most common prey fish was found to be anchovies. The fecundity for the analyzed samples ranged from 22,333 to 79,703 eggs. As there is confusion in the identity of the bullet tuna species found in Indian Ocean, DNA barcoding was carried out for 9 randomly selected samples. The mitochondrial cytochrome oxidase I (COI) region sequences confirmed that the species found in Sri Lanka is *Auxis rochei* with 99.6% similarity. Other *A. rochei* sequences from India, Indonesia and Taiwan downloaded from the NCBI database were compared with the 9 sequences used in the study. The neighbour joining tree created for all these sequences showed that the Sri Lankan *A. rochei* shows a very close relationship to *A. rochei* found in the other Indian Ocean countries.

Keywords: *Auxis rochei*, bar coding, bullet tuna, feeding

**Corresponding author - email: deishini.herath@yahoo.com*

Effect of two commercial feeds on growth and survival of the sea cucumber *Holothuria scabra* larvae

E. Thilakshi[1], N.Y. Hirimuthugoda[1], C.B. Medagedara[2] and P.A.D. Ajith Kumara[2]*

[1]*Department of Animal Science, Faculty of Agriculture, University of Ruhuna, Sri Lanka*

[2]*National Aquatic Resources Research and Development Agency (NARA), Crow Island, Colombo 15, Sri Lanka*

Holothuria scabra (sandfish) is one of the most valuable sea cucumber species exploited in the tropical areas throughout the world and it has been identified as an excellent candidate for aquaculture due to its superior taste, nutritional and medicinal values. However, there are many shortcomings in sandfish aquaculture and lack of appropriate larval feed is considered as one of such constrains. Therefore, this research was designed to study the effect of two commercially available larval feeds (Algamac 2000 and *Spirulina* PLUS) on the growth and survival of *H. scabra*. Natural brown seaweed, *Sargassum* sp. was used as the control diet in this experiment. Twelve fiber glass tanks of 250 L capacity filled with 120 L of UV treated sea water were used for the feeding experiment with four replicates for each feed type. In each tank, larval density was set at 100 indivi. L^{-1} and they were initially fed twice a day with microalgae (*Chaetocerous* sp.) from day 2 to day 10. Experimental feeds were introduced into tanks on the 8^{th} day and continued until day 35. Semi-circulated water flow system maintained throughout the experiment. Water temperature, salinity and dissolved oxygen (DO) were measured daily and maintained within optimum range. Number of juveniles in each experimental tank and their lengths were measured at the end of 35 days. Results revealed that 83.36±5.6 % larval survival per tank at the end of the day 8 and the average length of these individuals was 610±10.18 µm. Larvae fed with Algamac showed significantly higher mean length (21±3.6 mm) and survival (5.8±0.72 %) than individuals fed with *Spirulina* sp. (14±2.1 mm; 2.0±0.32 %,) and *Sargassum* sp. (12±2.1 mm; 1.1±0.79 %) at the end of larval rearing period ($p<0.05$; one-way ANOVA). Based on these results it can be concluded that Algamac can be considered as more suitable larval feed for *H. scabra* than *Spirulina*. and *Sargassum* sp.. Further research are recommended to find out low cost feeds which enhances growth and survival as reported survival is comparatively low and larval feeds used in this experiments are more expensive.

Keywords: aquaculture, commercial feeds, *Holothuria scabra,* sea cucumber, survival rate

**Corresponding author – email :ajithkumaranara@gmail.com*

Identification of possible carrier species responsible for horizontal transmission of white spot syndrome virus (WSSV) disease to cultured *Penaeus monodon*

M.R.L. Thanthrige*, S. Jayanatha, R.V. Narasinghe, J. Pushpa Kumara and V. Pahalawatthaarachchi

National Aquatic Resources Research and Development Agency (NARA), Crow Island, Colombo 15, Sri Lanka

White spot syndrome virus (WSSV) is the most important viral pathogen of farmed shrimp which often leads to severe economic loss to the farmers. The WSSV disease can cause up to more than 80% mortalities in cultivated penaeid shrimp stocks within 3 to 10 days. The WSSV has a wide host range, which extends to crustaceans, molluscs and arthropods which also act as apparently healthy carriers of the infection. The aim of this study was to investigate the pathogen carriers in the surrounding environment of shrimp farms in Northwestern Province of Sri Lanka from 2015 to 2016. A total of 561 tissue samples of nine different species of crustaceans and one species of mollusk were subjected to screening for the horizontal transmission studies. Disease prevalence areas were mapped from Wattala to Kalpitiya along the shrimp farming area of the Northwestern coast. Out of 561 samples screened through 2-step nested PCR, 53 individuals were found positive for the WSSV. The occurrence of infection was significantly low (2.2%) in wild shrimps (*Penaeus indicus, P. semisulcatus P. mergensis, Meganyctiphanes norvegica*). Occurrence of infection in mole crabs *(Emerita analoga*), blue swimming crabs (*Portunus pelagicus*), mangrove crabs (*Scylla serrata*), brine shrimp/artemia (*Artemia salina*), mud crabs (*Scylla olivacea*) and sand white ghost crabs (*Ocypode ceratophthalmus*) were 4.7%, 14.6%, 18.2%, 20.1%, 37.8% and 43.7% respectively. No actual incidences were recorded in three spotted swimming crabs (*Portunus sanguinolentus*) or in unidentified small crabs or in coastal bivalves (*Marcia opima*). The information generated from this study could lead to new approaches towards controlling the WSSV in a cost effective manner. As the precautionary measures and to control further contaminations from the wild, strict biosecurity measures should be adhered during WSSV outbreaks. Moreover, further studies with more sampling and to compare WSSV genotypes of possible species with that of WSSV infected shrimps would be required to determine the precise pattern of transmission.

Keywords: carriers, crabs, crustaceans, shrimp, white spot syndrome virus

*Corresponding author – email :rasi.thanthrige@gmail.com

Study of the impact of the fyke net fishery ("Kudu del") on *Portunus pelagicus* and other non-target species, in the Puttalam Lagoon (Gulf of Mannar) using the Marine Stewardship Council's Risk Based Assessment Framework

W.D.M.C. Wickramanayake* and M.F.M. Fairoz

Ocean University, Mahawela Road, Tangalle, Sri Lanka

The objective of the present study was to assess the impact of fyke net fishing, locally known as 'Kudu del' on *Portunus pelagicus* stocks and other non-target species (NTS) in Puttalam Lagoon. Field data were collected from the fyke net catches of fishermen operating in the Puttalam Lagoon from 14th of November to 2nd of December and 1st to 5th of February in Kurinjanpitiya landing site and a total of 100 fyke nets were sampled (200 fishing trips). The total weight of the catch landed was 531.61 kg, of which 293.29 kg (55.2%) were target prawn species. Main species of shrimp in the harvest were *Penaeus indicus, Penaeus semesulsctus* and *Penaeus monodon*. The total weight of NTS was 238.32 kg (44.8%). A total of 56 NTS were observed including reptiles (01), finfish (44), crustaceans (06), molluscs (03), echinoderms (01) and Cyaneidae (01). The study revealed that 17.8% by weight of NTS was retained and 27.1% by weight of NTS was discarded. The total weight of the *P. pelagicus* caught by 100 fyke nets was 46.105 kg (8.71%) and the total number was 418. Small crabs (*P. pelagicus*) were discarded. Average total weight of *P. pelagicus* per boat (for 200 fishing trips) was 230.05 g. The 62% of female blue swimming crabs caught were mature. No endangered, threatened or protected species or primary main or minor species were observed, according to the Marine Stewardship Council's (MSC's) risk based framework for data poor fisheries. *Enhydrina schistose* (Out of Scope), *P. pelagicus* (8.71%) and *Hephaestus obtusifrons* (7.46%) were identified as secondary main NTS. The automated results for the three secondary main NTS species identified in the fishery generated a Scoring Guide Post ≥80 when applied the MSC's risk based framework indicated the ecological status of the fyke net fishery to be consistent with an unconditional pass of the MSC's fishery assessment methodology.

Keywords: fyke net, non-target species, MSC's risk based framework, *Portunus pelagicus*, sustainable fisheries

**Corresponding author – email :chathurangi822@gmail.com*

Effect of low-cost formulated diets on the growth performance and survival of giant freshwater prawn (*Macrobrachium rosenbergii*)

K.W.R.R. Amaraweera*

National Aquatic Resources Research and Development Agency (NARA), Crow Island, Colombo 15, Sri Lanka

The change from extensive aquaculture system to semi–intensive aquaculture system has resulted in an increased demand in aquaculture feeds. *Macrobrachium rosenbergii* is a potential candidate in development of aquaculture and to make it as an income generating activity for small–scale fish farmers in Hambanthota District. However, due to the unavailability of feed ingredients and cost-effective channels to deliver feeds to *M. rosenbergii* farmers have contributed to poor production and profitability. A study was conducted to evaluate growth performance of *M. rosenbergii* fed with two different low-cost formulated diets containing, fish meal, soya bean meal, maize meal, rice bran, coconut oil cake, wheat flower, fish oil, and vitamin mixture, and a commercial diet (i.e. imported prawn diet Tom boy) for a period of 180 days. The crud protein contents of the first formulated diet (treatment-1), the second formulated diet (treatment-2) and the commercial diet (treatment-3) were 30.01±0.60 %, 27.20±0.15 % and 32.00±0.20 % respectively. The study showed that the growth rate, survival rate, feed conversion ratio and the total production of *M. rosenbergii* did not vary significantly (p>0.05 One-way ANOVA) between the three feed types. The production costs for the treatment-1 and the treatment-2 formulated diets were approximately Rs. 130 kg^{-1} and Rs. 110 kg^{-1} respectively compared to the commercial diet which was around Rs. 200 kg^{-1} in the local market. Therefore, formulated feed type 1 and 2 can be recommended as cost-effective feeds for the semi-intensive culture practices of *M. rosenbergii* in mud ponds particularly in the rural areas of the country.

Keywords: cost-effective feed, feed conversion ratio, crude protein, semi-intensive culture

**Corresponding author – email :ruchiraamaraweera@yahoo.com*

Improving the governance framework to combat IUU fishing: Suggestions based on fishermen's responses

S. Rasanjala Karunathilaka*, H.R.L.C. Bandara and M.I.U. Manikarachchi

Ocean University of Sri Lanka, Mahawela Road, Tangalle. Sri Lanka

The purpose of this study is to provide suggestions to improve the national governance framework for combating Illegal, Unreported and Unregulated (IUU) fishing in Sri Lankan waters based on the attitudes of the fisheries communities. A questionnaire survey was conducted among the groups of fishermen in Kudawella, Dondra, Kalpitiya and Cod-Bay fishing harbours to observe their responses on the prevailing regulatory mechanism. The questionnaire was prepared referring to the current law implementation mechanism to combat IUU fishing at national level, which is the duty of the Department of Fisheries and Aquatic Resources (DFAR). Fisheries and Aquatic Resource Act No 2 of 1996 is the main legal instrument that regulates fishing operations in the Sri Lankan EEZ. No 35 of 2013 amendment and certain extraordinary gazettes assert the rules for fishing operations in high seas. To develop the level of awareness of fishermen on compliance, awareness programmes are being organized by the DFAR. Regardless of these efforts, the number of offences related to IUU fishing in the Sri Lankan waters has increased in the past three years. The results showed that there are many loopholes and weaknesses in the process of law implementation. Only 44% of the visited boats during the survey had vessel monitoring systems (VMS) installed. Fishermen face many problems because of the miscommunication between them and fisheries inspectors. The 60% of fishermen responded that they are willing to participate in training programmes, but do not regularly get free time. 73% claimed that they have seen foreign vessels fishing in the Sri Lankan EEZ. They suggested course nets to be completely banned and some mechanisms for non-target species to escape from fishing gear. It is costly to install VMS and operate them for a long time. The 75% of fishermen responded that their daily catches have been reduced due to new regulations on IUU fishing.

Keywords: IUU fishing, law implementation, vessel monitoring systems, Department of Fisheries and Aquatic Resources

**Corresponding author – email :shashinikarunathilaka@gmail.com*

Growth performance of ornamental koi carp (*Cyprinus carpio*) fed on a diet supplemented with meat meal made out of rejected chicken

W.S. Malinda Harsha Kumara, M.S.M. Nafees* and M. Pagthinathan

Faculty of Agriculture, Eastern University, Sri Lanka, Vantharumoolai.

A 42-day feeding trial was conducted to evaluate the effect of diets formulated using fish meal and chicken meat meal on the growth of ornamental koi (*Cyprinus carpio*) juveniles. Two isonitrogenous (CP 42%) experimental diets were prepared using imported fish meal (T_1) and chicken meat meal (rejected chicken; T_2). A commercial fish feed was used as the control (T_3). Ninety of 28-days old mixed-sex koi juveniles were randomly allocated to nine glass tanks (45×30×30 cm^3 each) at a stocking density of 10 fish per tank. Each treatment had three replicates. The results showed that there was no differences (p>0.05) observed in weight gain, specific growth rate, feed conversion ratio and survival of fish fed with control and experimental diets. The results indicated that meat meal prepared from rejected chicken could be utilized as a protein supplement in juvenile koi feeds to replace high cost fish meal. The current study reveals that ornamental *Cyprinus carpio* could be raised successfully on a feed prepared from chicken meat meal made out of rejected chicken for human consumption.

Keywords: chicken meat meal, *Cyprinus carpio*, koi carps, specific growth rate

**Corresponding author – email :mohamednafeez@yahoo.com*

Establishment of *Gracilaria edulis* propagules by raft culture method in Puttalam Lagoon, Sri Lanka

F. Ashika[1], N.Y. Hirimuthugoda[1] and V. Pahalawattaarachchi[2]

[1] *Department of Animal Science, University of Ruhuna, Wellamadama, Matara*

[2]*National Aquatic Resources Research and Development Agency (NARA), Crow Island, Colombo 15, Sri Lanka*

Gracilaria edulis is the principal source of agar which has a high demand in foreign markets. The resource depletion has been observed since 1998 due to natural phenomena but regeneration was evident recently. Although the natural stocks are underutilized at the moment, there is a high potential for cultivation of *G. edulis* in Sri Lanka. Present study was carried out from October to November 2016, with the aim of determining the optimal depth and weight of *G. edulis* propagules needed for commercial culture and the effects of water quality on growth in Puttalam Lagoon during the study period. The two factors randomized complete block design method was used to design the trial. The weight and depth had two levels as 50 g, 100 g and 15 cm, 25 cm from the surface respectively. Two floating rafts with PVC pipes (1.8 x 1.6 m) were constructed with 08 parallel lines and they were fixed in the lagoon beneath 15 and 25 cm depth from the surface and propagules were collected from the natural seaweed beds in Puttalam Lagoon. The wet weight of each propagule, water quality parameters and water flow were measured biweekly. Subsequently daily growth rate (DGR) and flow rate were calculated. The highest DGR of 4.32±0.581 %/day was recorded at the depth of 15 cm and 50 g propagules at the end of 60 days of culture period. The DGR for 100 g of propagules at the same depth was 3.59±0.24 %/day. The DGR at the depth of 25 cm for 50 and 100 g of propagules were 3.98±0.246 %/day and 3.34±0.14 %/day respectively. High fluctuation of DGR had occurred due to fragmentation of algae with heavy wave actions during the Northeast monsoon period. The results revealed that DGR is significantly affected by nitrate, ionized ammonia and water flow (p<0.05) but nitrite, pH, phosphate and salinity were not significantly affected on DGR (p>0.05). In summary, the optimum growth of *G. edulis* could be obtained by using floating raft at 15 cm depth with 50 g propagules during Northeast monsoon period in the Puttalam Lagoon.

Keywords: daily growth rate, floating raft method, *Gracilaria edulis*

**Corresponding author – email :vasalanka@gmail.com*

Effect of dietary lipid level on growth performance of *Garra ceylonensis*, Ceylon stone sucker *(Bleeker, 1863)*

M. K. F. Shabnam[1]*, K. Radampola[1], E.D.M. Epasinghe[2], A.M.A.N. Adikari[2] and T.A.D.W. Karunaratne[2]

[1]*Department of Fisheries and Aquaculture, Faculty of Fisheries and Marine Science & Technology, University of Ruhuna, Matara*

[2]*National Aquatic Resources Research and Development Agency (NARA), Crow Island, Colombo 15, Sri Lanka*

Garra ceylonensis is an endemic fish species in Sri Lanka, which is recognized as spafish, and most exported among endemic fish of Sri Lanka. The aquaculture practices of this species are still not reported and literature on nutritional requirements of *Garra* sp. is limited. This study attempted to assess the lipid requirement for sub adult stage of *G. ceylonensis* under aquarium condition. Growth and survival of premature, unsexed, tank bred *G. ceylonensis* was evaluated during a 45 day period. Seven weeks old *G. ceylonensis* (total length and bodyweight were 6.3 ±0. 28 cm and 2.49±0.4 g) were reared in glass tanks (45 x 45 x 45 cm) at a stocking density of 12 fish per tank. The feeding trial was conducted for 45 days in ambient condition and fish were fed on four isonitrogenous (38%) diets with 6% (L6), 9% (L9), 12% (L12) or 15% (L15) lipid level up to satiation twice (0900 hr and 1500 hr) daily. There was no significant difference observed in survival of fish among different treatments. Final total lengths were 6.70±0.49, 6.65±0.26, 6.56±0.37 and 6.72±0.25 cm and weights were 3.25±0.56, 2.98±0.46, and 3.08±0.50 and 3.15±0.40 g. The final weight of L9 fed fish was significantly different from L6 and final length of L12 fed fish was different from L6 fed fish. Survival was 100% and, the feed conversion ratio were 2.58±0.55, 3.16±0.30,2.99±0.32 and 2.91±0.21 for L6, L9, L12 and L15 respectively. Further, long term studies are needed to evaluate the dietary nutrient requirements of *Garra* under aquarium conditions

Keywords: *Garra ceylonensis*, growth performance, lipid requirement

**Corresponding author – email:mkfshabnam@gmail.com*

An introduction of baited traps for harvesting bottom dwelling crustaceans in the trawling grounds in the West coast of Sri Lanka

A.A.S.H. Athukoorala* and K.G.S. Nirbada

National Aquatic Resources Research and Development Agency (NARA), Crow Island, Colombo 15, Sri Lanka

A baited trap was tested to find out the catching efficiency of marine crustaceans at a trawling ground (Negombo) in the West coast of Sri Lanka during 2015 and 2016. Traps were oval in shape and constructed with a metal frame painted with anticorrosive paint and covered with nylon fishing nets of 20 mm mesh size. A narrow funnel shaped mouth was placed on the top of the trap. Each unit was baited with four different bait types, Indian mackerel, dry fish, oil cake and herring (*Amblygaster sirm*) to attract crustaceans. One bait type was used for one fishing trial. Each trap was provided with a 2 m long branch line that was attached to a mainline using snap clip at 10 m intervals. Fifteen such traps were laid on the sea floor at the trawling ground and kept overnight. A total of 799 crabs and 66 shrimps and 20 fish species were harvested from 21 trials. The crab catch (87%) was dominated by the *Portunus sanguinolentus* (three spot swimming crab) followed by *Portunus pelagicus* and *Scylla serrata*. The shrimp catch (11%) was composed of *Metapenaeus affinis*, *Metapenaeus dobsoni*, *Parapenaeopsis coromandelica* and *Penaeus merguiensis*. The fish catch was only about 2%, which comprised of families of Cyanoglossidae, Carangidae and Sciaenidae. The effectiveness of four different baits in catching crustaceans was tested during the study. A significant difference in terms of the catch rates was observed by One-way ANOVA test among four different baits ($p<0.05$). The highest average catch rate (9.2 kg/set) was recorded for the discarded dry fish parts used as a bait. The estimated average catch rates for other bait types (oil cake 5.0 kg/set, Indian mackerel 4.7 kg/set and herrings 2.0 kg/set) were recorded respectively.

Keywords: baits, swimming crabs, traps, trawl grounds

**Corresponding author – email :sujeewahemanthi@gmail.com*

Suitability of *Artemia* as a model organism on acute hepatopancreatic necrosis causing pathogen

M.A.A.P. Kumari[1]*, P. Deschryver[2] and P. Bossier[2]

[1]*Department of Animal and Food Sciences, Faculty of Agriculture, Rajarata University of Sri Lanka, Mihintale, Sri Lanka*

[2]*Laboratory of Aquaculture and Artemia Reference Center, Faculty of Bioscience Engineering, Ghent University, Rozier 44, 9000 Ghent, Belgium*

The recent outbreak that affected to shrimp aquaculture sector was early mortality syndrome or acute hepatopancreatic necrosis disease (EMS/AHPND). In 2013, the causative agent of EMS/AHPND was identified as *Vibrio parahaemolyticus*. Treatments for EMS/AHPND are still unavailable and a fast screening method for the possible treatment is required due to the limited applicability on usage of the shrimp post-larvae. Hence, usage of a model organism will help for fast screening of possible treatments on EMS/AHPND. Thus, this study was conducted to assess the possibility to use *Artemia nauplii* as a model organism on pathogenic *V. parahemolyticus*. In this study, seven bacterial strains were used and those were diagnosed by recently developed PCR method for EMS/AHPND with specific primer pairs of AP2F, 5'- TCACCC GAA TGC TCG CTT GTG G -3'; AP2R, 5'- CGT CGC TAC TGT CTA GCT GAA G-3' and AP3F, 5'ATGAGTAACAATATAAAACATGAAAC-3',AP3R,5'GTGGTAATAGATTGTACAGAA-3'. Gnotobiotic *Artemia nauplii* were challenged with positive strains at three different dosages (10^3,10^5 and 10^7 CFU ml^{-1}) in presence or absence of growth medium. According to the results of PCR amplification, all positive and one negative *V. parahaemolyticus* strains were produced the positive results and it implies that primer AP2 and AP3 produced the false positive results. Hence, it is requires further confirmation with newly developed AP4 primer for improved confirmation. It was found that all positive strains were virulent towards the *Artemia* nauplii in different degree and it is possible to use this character to determine the strength of the possible treatments. Presence of growth medium resulted varied dose depended relationship of the *Artemia nauplii* with different strains. However, absence of growth medium showed proportional reduction of the survival percentage of the *Artemia* with an increase of the dosage. Based on the challenge test results it is possible to conclude that, *V. parahaemolyticus* is virulent towards the *Artemia nauplii* and virulence of the each strains are clearly depend on the density of the strain, type of the strain, and medium which is used for challenged *Artemia*.

Keywords: acute hepatopancreatic necrosis disease, challenge test

**Corresponding author – email : a.pubudu@yahoo.com*

Nature and diversity of batoid fisheries in the commercial landings of Sri Lanka; a case study from Jaffna, Beruwala, Negombo and Chilaw

H.A.C.C. Perera*, R.A.M. Jayathilake, H.M.W. Bandara, U. Seneviratne, V.K. Ranasinghe and M.D.I.C. Kumara

National Aquatic Resources Research and Development Agency (NARA), Crow Island, Colombo 15, Sri Lanka

Present study provides information about status and diversity of batoid fish in major fish landing sites namely; Jaffna (Mathagal and Munai), Negombo, Chilaw and Beruwala. The batoid catches landed at these landing sites were monitored monthly during the period of January, 2016 to December, 2016. Batoids are mainly caught with bottom set gill nets and bottom set longlines operated frequently by OFRP boats. Moreover, batoids were also landed in multiday boats. Herrings (*Amblygaster sirm*), sardines (*Sardinella albella*, *S. gibbosa*) or squids (*Loligo* sp.) were used as the bait. In Jaffna, these species are caught as target species, but in other landings they are caught as by catch. In the four fishery harbours investigated, a total of 28 batoid species belonging to two orders (Myliobatiformes and Torpediniformes), belonging to six families were recorded. During the study, Dasyatidae (higher in day boat catches), Myliobatidae, Gymnuridae, Mobulidae (higher in multiday boat catches), Rhinobatidae and Narcinidae were recorded. Of the observed catch in Jaffna, random sampling of each boat revealed that 65% of the catch consisted of *Himantura undulata* (Leopard whipray 56-237 cm disc width), *Aetobatus narinari* (Spotted eagle ray 48-137 cm disc width) and *Rhinoptera javanica* (Javanese cownose ray). The large size *Himantura* species were caught more in Jaffna than in other landings; in Chilaw over 80 % of the total catch consisted of *Dasyatis kuhlii* (Blue spotted stingray 20-47 cm disc width), *Dasyatis zugei* (Pale-edged sting ray 10-22 cm disc width) and *Himantura undulata* (Leopard whip ray 25-93 cm disc width), and in Negombo and Beruwala, the total contribution of *Manta birostris* (Oceanic/ Giant Manta ray) and *Mobula japanica* (Spinetail mobula) were 70% and 75% respectively. Females with pups were observed for the species *Dasyatis kuhli, Gymnura micrura* and *Aetobatus narinari* and *Dasyatis zugei* was observed with fully matured eggs.

Keywords: batoids, rays, catch, fishery, OFRP

**Corresponding author – email :chinthaperera2@yahoo.com*

Status of brackish water shrimp fishery in Southern coastal area, Sri Lanka

K.H.K. Bandaranayake*, R. Maldeniya and A.A.S.H. Athukoorala

National Aquatic Resources Research and Development Agency (NARA), Crow Island, Colombo 15, Sri Lanka

The present study was undertaken with the view of studying the current status of brackish water shrimp fishery with respect to craft- gear type, fishing effort and catch rates in the Southern coastal stretch between Benthota to Matara; including Benthota- Thalan Ganga, Madu Ganga, Kosgoda Ganga, Ambalangoda Ganga, Rath Ganga, Gin Ganga, Koggalalake and Nilwala Ganga. The rapid survey was conducted from August to November, 2015 and the results were mainly based on the information gathered from fishermen at the landing sites. Shrimp fishery in Southern coastal belt is entirely artisanal and is conducted either using wooden or fiberglass canoes or sometimes without a craft. There are only three types of gear operated targeting shrimps: set gillnets, cast nets and kraals (Ja-kottu). Mesh sizes of gillnets targeting shrimps vary as 5/8", 1 ¼", 1 ¾", 1 ½", 2"and 2 ½". *Penaeus indicus, P. monodon, P.semisalcatus, Metapenaeus dobsoni, M. elegans* and *Macrobrachium* sp. are the dominant shrimp species found in the area. Catch rate of gillnets varied in between 2-5 kg per operation. Among the landing sites examined, there is no shrimp fishery in Kosgoda Ganga after the tsunami. Fish kraals are located only in three places, the highest number is in the Madu Ganga (50) followed by Benthota- Thalan Ganga (12) and only three kraals in Rath Ganga. Majority of fish kraals are made up of mangrove/ bamboo beams and only few are made up of synthetic materials. Average catch per kraal (dominated by *P. indicus*) is around 300 kg/month where daily catch rates are varied in between 5-15 kg. Shrimp catch rate for the cast net during the peak season ranged in-between 2-3 kg. Even though, a year round fishery exists for shrimps in the area, December to May is the best fishing season.

Keywords: shrimp, southern coast, brackish water fishery

**Corresponding author – email : kisharabandaranayake@gmail.com*

A preliminary study on potential fishery for octopus in Sri Lanka using a newly introduced fishing gear

S.J.W.W.M.M.P. Weerasekera*, M.I.G. Rathnasuriya, R.P.P.K. Jayasinghe, S.C.V.U. Senevirathne, R.R.C. Maldeniya and A.A.D.G. U. Amarakoon

National Aquatic Resources Research and Development Agency (NARA), Crow Island, , Colombo 15, Sri Lanka

The demand for new fisheries resources is always high due to increasing world's human population. Exploration of new candidates for export oriented markets is beneficial for the economy of a country. At present, there is no target fishery for octopus in Sri Lanka and they are mainly landed as a by-catch of the trawl fishery, which is mainly carried out in the North and Northwest coasts of Sri Lanka. Even though, locally there is no good demand for octopus, an increasing demand is observed internationally. Therefore, this study aimed to identify the potential areas for octopus fishery in the North and Northwest coasts of Sri Lanka, where octopuses are frequently caught and possibility of introducing new fishing gear (trap) to target octopus. A preliminary study was carried out from January to December, 2016. Experiential fishing using traps was conducted in the coastal sea of Pukulam in the Northwest coast with the community participation. One hundred numbers of traps connected to a common longline by 30 cm long branch-lines with 1 m spacing between two taps. Six lines of traps of this particular array were constructed, thus generating a total of 600 net traps for the experiment. Traps were deployed at a depth of 10 m and soaked for 24 hrs. Traps deployed were un-baited because, octopuses enter traps as a habitat alternative to natural creviced structure. The trial fishing revealed the possibility of using the fishing gear for catching octopus as it captured wild octopus with a mean catch rate of 05 indivi./100 traps/day. The species recorded was *Amphioctopus aegina*. Majority of the specimens tested were matured (60%) and male to female sex ratio, was 1:1. Evidences from trawl catches and experimental fishing conclude that the coastal waters in the surveyed areas particularly, the areas where trawl fishery is carried out are associated with potential octopus resource. Mean catch rate of 05 indivi./100 traps/day reflects that the trap seems to be efficiently reacting for octopus attraction. Therefore, further research is suggested in order to determine the potential of harvesting the resource with newly introduced gear.

Keywords: *Amphioctopus aegina*, North and Northwest coasts, octopus, Sri Lanka, traps

**Corresponding author – email :madhurapro@gmail.com*

Oceanography and Hydrography

Fishing depth prediction for tuna longlines; An improved fishing ground forecasting system for Sri Lanka

S.S. Gunasekara* and J.K Rajapaksha

National Aquatic Resources Research and Development Agency (NARA), Crow Island, Colombo 15, Sri Lanka

Fishing ground forecasting system for tuna fishery in Sri Lank was introduced in 2008 and methodology improvements have been continuing since its launch. Accurate swimming depth of yellow fin tuna (*Thunnus albacares*) is important to increase the catch efficiency in longline catches. An improved methodology had been developed in 2014 to predict fishing depths using sea surface temperature and sea surface height data obtained from satellites. However, accuracy of those predictions is limited due to ocean surface conditions affected by winds 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 regular information on physical state and dynamics of global oceans in 1/4° spatial resolution based on models. Information provided is more advantages due to its multiple data sources with high spatial and temporal resolutions. With the new methodology, prediction of fishing depths was improved. Fishing depths are critical information to enhance the catch rates. Thus, the fishing depth prediction was coupled with the existing tuna forecasting system. It is expected that the catch rates of longline operations will be enhanced with this improvement.

Keywords: fishery forecasting, longline, yellowfin tuna

**Corresponding author – email: s22gtech@gmail.com*

Diversity, abundance and biomass of marine zooplankton in relation to nutrients in Southern Bay of Bengal

Y.P. Kumara[1] and H.B. Jayasiri[2]*

[1] *Marine Environment Protection Authority, Colombo 09, Sri Lanka*

[2] *National Aquatic Resources Research and Development Agency (NARA), Crow Island, Colombo 15, Sri Lanka*

Hydrography, nutrients and planktonic fauna were evaluated at seven sites in the southern Bay of Bengal (BOB) during August 2015. Vertical profiles of salinity, temperature and dissolved oxygen (DO) were made using conductivity, temperature, depth profiler and water samples were collected using Rosette Sampler in R/V Roger Revelle. Zooplankton samples were collected by using WP-2 plankton net (180 µm) by vertically towing from 50 m to the surface. Zooplankton were counted and identified under the Sedgwick rafter cell using light microscope. Water samples were analyzed for nutrients and chlorophyll-*a* using spectrophotometer. The secondary production was evaluated using different biomass indices of zooplankton such as wet weight, dry weight, ash free dry weight and displacement volume. The highest chlorophyll-*a* level of 0.63 µg/l was found at 25 m among all depths in the study area. Zooplankton abundance varied from 2.38 to 8.36 indivi./l with a mean of 4.60±0.87 indivi./l in the study area. The copepods were the most abundant taxon at all sites and they contributed 48% to the total zooplankton community in southern BOB. One-Way ANOVA was performed for the study area of southern BOB and found that wet weight significantly varied between western and eastern sides of southern BOB at p=0.05 and significantly high wet weight was found in western side. Dry weight and ash-free dry weight did not vary significantly between western and eastern sides of southern BOB (P>0.05). Highest NO_3^-+NO_2-N, PO_4^{3-}-P and SiO_4^{4-}-Si concentration was found at 200 m depth. This study provides information on secondary producers in relation to physical and chemical oceanographic parameters in the southern BOB.

Keywords: Bay of Bengal, secondary production, zooplankton biomass, nutrient

**Corresponding author – email: hbjayasiri@gmail.com*

Variation of the abundance and composition of dinoflagellates in three sea bathing sites in the Western and Southern coasts of Sri Lanka

A.P. Weerakoon[1], H. B. Jayasiri[2*], S.C. Jayamanne[1] and K.P.G.K.P. Guruge[1]

[1] *Faculty of Animal Science and Export Agriculture, Uva Wellassa University, Badulla.*

[2]*National Aquatic Resources Research and Development Agency (NARA), Crow Island, Colombo 15, Sri Lanka*

Dinoflagellates are an important group of phytoplankton which inhabit both marine and freshwater environments. Marine dinoflagellates are well known for producing toxins. In the present study, the abundance and composition of marine dinoflagellates in the coastal waters of Mount Lavinia, Unawatuna and Polhena were investigated during August to December, 2016 in relation to nitrite, nitrate, phosphate and silicate concentrations. Replicate water samples (10 L) (n = 5 for Mount Lavinia and Unawatuna; n=3 for Polhena) were collected from each site and filtered through a 10 µm mesh. The plankton retaining on the mesh were collected and preserved with Lugol's solution, identified using standard keys and counted under the light microscope. In addition, nitrate, nitrite, phosphate and silicate concentrations of water in each site were determined by colorimetric method while the total suspended solids (TSS) were determined by a gravimetric method. Results revealed that dinoflagellates contributed to 6.30% of the total phytoplankton community. Altogether 36 species of dinoflagellates belonging to 12 genera were identified. Of these, 16 species were identified as toxic species belonging to the genera *Alexandrium, Akashiwo, Dinophysis, Noctiluca, Prorocentrum, Protoperidinium* and *Scrippsiella*. *Prorocentrum lima* was the dominant toxic dinoflagellate species followed by *Scrippsiella trochoidea*. Temporally significant toxic dinoflagellate abundances were reported in September (68 cells/L) and November (60 cells/L) while spatially significant toxic dinoflagellate abundance was reported at Polhena (58 cells/L) ($p< 0.05$; Two-way ANOVA). The dinoflagellate abundances were positively correlated ($p< 0.01$) with silicate concentration in water. The low density of dinoflagellates and toxic species suggest a less possibility of algal blooms. The detailed studies should be conducted to identify and distribution of toxic dinoflagellates to establish safe sites for bathing and recreational activities.

Keywords: dinoflagellates, Mount Lavinia, Polhena, sea bathing sites, Unawatuna

**Corresponding author – email: hbjayasiri@gmail.com*

Comparison of measured and modeled sea surface salinity and temperature at the East of Sri Lanka during Northeast monsoon in 2014 and 2015

Akila Harishchandra* and S.U.P. Jinadasa

National Aquatic Resources Research and Development Agency (NARA), Crow Island, Colombo 15, Sri Lanka

HYbrid Coordinate Ocean Model (HYCOM) is a global ocean prediction system which produces simulations of oceanographic parameters (Ocean temperature, salinity and geostrophic currents). Currently, HYCOM derived data are widely used in regional ocean circulation and bio-physical models to understand local hydrographic phenomena. It is important to validate the model simulations to assess the accuracy of the model. During this study, modeled data obtained from HYCOM model were compared with the in-situ measurements. Sea surface salinity (SSS) and temperature (SST) data which derived from HYCOM model was compared with in-situ conductivity temperature and depth (CTD) measurements obtained from R/V Samuddrika vessel during November to December 2014 and 2015. CTD data were post processed and HYCOM data were interpolated to the nearest CTD sampling points. Root mean-square difference (RMSD) and relative RMSD values were calculated. Though, in-situ SST varied from 28.12 ^{o}C to 30.58 ^{o}C, model simulated values varied from 27.95 ^{o}C to 29.69 ^{o}C. In-situ SSS values varies from 26.49 PSU to 33.75 PSU. However, model simulated values were ranged between 33.58 PSU and 34.49 PSU. Calculated RMSD and RRMSD between in-situ and modeled SST was 0.57 and 0.02 respectively and RMSD and RRMSD between in-situ and modeled SSS was 4.56 and 0.14 respectively. This study suggested that the global HYCOM is more reliable in simulating SST than SSS. East coast of Sri Lanka is subjected to highly dynamic hydrographic phenomena during this period (Passage of East Indian Coastal Current along the east coast of Sri Lanka) which drops SSS dramatically, though global HYCOM model may unable to simulate such regional phenomenon. But it is able to simulate SST with reliable accuracy. Applicability of global HYCOM SST products for other studies such as coral reef mass bleaching predictions in Sri Lanka is recommended to assess in future studies.

Keywords: East Indian Coastal Current, Global HYCOM, SST, SSS

**Corresponding author – email: akila.uor@gmail.com*

Evaluation of dredging impacts on sand excavation using geophysical techniques: case study from Colombo Port City development project

N.B. Suriyaarachchi*

National Aquatic Resources Research and Development Agency (NARA), Crow Island, Colombo 15. Sri Lanka

Acoustic imaging can be employed to evaluate sea bottom morphological changes due to many marine development projects. Though, large scale development projects are in progress in Sri Lankan waters, current status has not been evaluated and sea bottom morphological impacts have not been assessed. To fulfill such gaps, the effectiveness of side scan sonar and single beam bathymetric survey results were evaluated. The investigations were carried out during the period of 14th November to 18th December, 2016 in off Negombo area. Two hundred meter (200 m) line spacing was maintained throughout the side scan sonar survey. The results indicated that the average depth of this area is around 25 m. Small elongated reef with approximately 80 m long, sand ripples, pits and boulders were recognized during this survey. Several dredging locations (about 2.5 km^2) in the survey area were clearly identified. Faded and distorted dredging signs could be identified in some locations while dredging tracks were totally covered by background materials in some places. That indicates bottom surface may affected by strong bottom currents and sediment transportation may occur in intense order to fill the dredging tracks. Single beam survey results indicated that the technique is effective to identify large scale topological changes. Reducing line spacing may increase its spatial resolution. Side scan sonar technique showed good potential to identify affected areas by dredging and present status of dredging sites. Periodic monitoring with side scan sonar is recommended for continuous impact monitoring for precautional planning to be taken to minimize dredging impacts.

Keywords: dredging, Port City, side scan sonar survey, single beam survey, topological changes

**Corresponding author – email: nuwan1985@gmail.com*

Ocean turbulence and mixing around Sri Lanka

S.U.P. Jinadasa[1]*, Iossif Lozovatsky[2], P.N. Ranasinghe[3] and H.J.S. Fernando[2]

[1]*National Aquatic Resources Research and Development Agency (NARA), Crow Island, Colombo 15, Sri Lanka*

[2]*Department of Civil Engineering, Environmental and Earth Sciences, University of Notre Dame, Notre Dame, IN 46556, USA*

[3]*Department of Oceanography and Marine Geology, University of Ruhuna, SriLanka*

Turbulence and mixing is important phenomena in ocean which stirs and mixes sea bottom and makes surface water highly productive. It is important to know what processes are involved in making ocean waters productive and this is the first such effort has been taken to identify the plausible processes around Sri Lanka. Detailed measurements campaign was conducted using vertical micro-structure profiler, conductivity temperature depth profiler and Acoustic Doppler current profiler (ADCP) for turbulence and mixing studies during 2013 and 2014. Results reveal that very strong stratification in the sharp Bay of Bengalpycnocline can damp wind-induced mixing, preventing the penetration of turbulence below a thin surface layer (15-20 m). Surface low-salinity layer was effectively decoupled from the thermohalocline during the moderate wind (11-12 ms^{-1}). However, horizontal/temporal gradients of temperature and salinity still exist above the mixed layer depth (MLD < 15-20 cm). The mixed layer deepened only slightly in higher winds (16-18 ms^{-1}) but being decoupled from the pycnocline. Substantial convective cooling and/or strong wind mixing in the upper layer during the Northeast monsoon was detected in south of Sri Lanka. The forcing gradually relaxed towards the transition period. The spatial structure of the dissipation rate is quite different along meridional and zonal transects to the south (WS) and to the east (TS) from Sri Lanka which crossed the summer monsoon currents (SMC) and East Indian coastal currents. The main features of turbulence in SMC were mostly confined to the surface mixed layer, which is detached from water interior by a strong pycnocline. Turbulence patches in the northern part of WS are appears to be generated by the influence of shelf break and then advected to the water interior. Contrary to SMC turbulence, the high-level dissipation along TS was mostly confined in a very narrow and sharp slopping upper pycnocline. The most probable source of such turbulence could be the strong shear instability at narrow interfaces, which was recorded in ADCP data in the lower secondary pycnocline (70-80 m).

Keywords: Bay of Bengal, ocean turbulence, mixing

**Corresponding author – email: udaya@nara.ac.lk*

Spatio-temporal variation of total suspended solids at surface waters of off Colombo

H.B. Jayasiri*, S.U.P. Jinadasa, K. Arulanandan and D.D.D. Weragodatenna

National Aquatic Resources Research and Development Agency (NARA), Crow Island, Colombo 15. Sri Lanka

Both organic (phytoplankton, zooplankton and detritus) and inorganic (clay, silt and sand) solids are included in total suspended solids (TSS). Suspended particles may smother benthic habitats or suffocate newly hatched larvae and fill the spaces between the rocks which serve as a habitat for these aquatic organisms. Two years TSS data were analysed to study the spatio-temporal variation in relation to rainfall. Surface water samples were collected monthly at five sites in 2015 and 2016, analysed for TSS. Five sampling sites include: mouth of the Kelani River, proximity to dredging and reclamation areas of the Port City Development Project, canal mouth of the Port and Beira Lake outfall. The mean (±SD) TSS concentration in 2015 and 2016 was 5.47±2.97 mg/l and 5.63±2.51 mg/l respectively and there was no significant difference at $p=0.05$. Though TSS concentration varied significantly spatially and temporally for the year 2016, there was no significant difference in 2015 in space and time at $p=0.05$. Significantly, high TSS concentration was reported in October 2016 while significantly high TSS concentration was reported in Kelani River mouth. There was no significant correlation between TSS and rainfall of Colombo for both years at $p=0.05$. Therefore, it can be suggested that in addition to the river discharge of the Kelani River, the combine effects of dredging and reclamation activities of the area have been affected to the TSS concentration in the area consequently on the alteration of benthic habitats.

Keywords: dredging, rainfall, reclamation, river discharge, TSS

**Corresponding author – email: hbjayasiri@gmail.com*

Latency effect on single beam echo-sounder bathymetry

M.D.E.K. Gunathilaka*, P.G.C.C. Fonseka, J.K.S.M. Priyasad, K.H.J.I. Yasarathna and H.R.S. Madhushanka

Faculty of Geomatics, Sabaragamuwa University of Sri Lanka, Belihuloya,70140, Sri Lanka

The global navigation satellite system (GNSS) is used for surface positioning during depth measurement using acoustic technology like single beam echo-sounder (SBE). The final bathymetry (x,y,d) is computed by the hydrographic data logging software. Latency is the time lapse between the actual observation time of a particular system and the time it is saved in the logging software in the logging computer. Latency error or time gap of the data has been one of the major problems in the hydrographic data collection. In multi beam echo-sounder systems (MBES), resolving the latency error is a must during the system calibration or special devices are used to time tag the data. In SBE data collection, most of the time, it is simply ignored as full bottom coverage is not possible. During this study, how the latency in a survey system effect to the final bathymetry is discussed. At first, the effects are simulated for various latency values from 0 to 1 second on a synthetic sea bed. Profile comparisons and contour matching was done to investigate the effect due to the latency in this study. The effects due to the various vessel speeds were also tested. Some real data sets collected at Colombo Port were used. A simple software application tool was developed to compute the latency value. According to the simulated results, with the increase of the latency value, the waviness of the depth contours increased. It is noticed that there is no effect from vessel speed to the latency value of the system. The obtained latency value for the system was 0.715 seconds in the real data set. Then after applying the corresponding latency corrections to the profile lines, the averaged mismatch was reduced from 3.8 to 0.3 m and the corresponding lines were matched.

Keywords: bathymetry, hydrography, latency, single beam echo-sounder

**Corresponding author – email: erandakan@geo.sab.ac.lk*

Derivation of high resolution bathymetry from multispectral satellite imagery

W.A.A.P. Wijesundara, R.M.D.I. Ratnayake* and A.N.D. Perera

National Aquatic Resources Research and Development Agency (NARA), Crow Island, Colombo 15. Sri Lanka

Bathymetric information is fundamental importance to coastal and marine planning and management, nautical navigation, and scientific studies of marine environments. Satellite derived bathymetry can be used in areas where conventional sounding data is lacking and conventional surveys are inaccessible. Log linear bathymetric inversion model and non-linear bathymetric inversion model provides two empirical approaches for deriving bathymetry from multispectral satellite imagery, which have been refined and widely applied over the last decade. This paper compares these two approaches by means of a geographical error analysis for the site Kankesanturai using WorldView-2 satellite imagery. In order to calibrate both models; single beam echosounding (SBES) data were used as reference points. The geographical distribution of model residuals was mapped and their spatial autocorrelation was calculated as a basis for comparing the performance of the bathymetric models. Comparisons reveal consistent geographical properties of errors arising from both models. A spatial error model is used to generate more reliable estimates of bathymetry by quantifying the spatial structure (autocorrelation) of model error and incorporating this into an improved regression model. Log linear model (R^2=0.846) performs better than the non-linear model (R^2=0.692). Finally, the spatial error models improved bathymetric estimates derived from linear and non-linear models up to R^2=0.854 and R^2=0.704 respectively. The root mean square error (RMSE) was calculated for all reference points in various depth ranges. The magnitude of the prediction error increases with depth for both the log-linear and the non-linear inversion models. Overall RMSE for log-linear and the non-linear inversion models were ±1.532 m and ±2.089 m respectively.

Keywords: bathymetry, log linear model, multispectral satellite imagery, spatial error model

**Corresponding author – email: dulapr37@gmail.com*

Aquatic Environment Conservation and Management

Study on diazinon pesticide adsorption to soil and its impact on two species of zooplankton

K.C.S. De Silva[1], A. A. D. Amarathunga[2]* and S. C. Jayamanne[1]

[1]*Department of Animal Science, Uva Wellassa University, Badulla, Sri Lanka*

[2]*National Aquatic Resource Research and Development Agency (NARA), Crow Island, Colombo 15, Sri Lanka*

Diazinon is an organophosphate categorized under insecticide. When pesticides are applied, they are subjected to different complex processes and there is lack of understanding of pesticide behaviour under tropical conditions. Adsorption is one of the main processes of the pesticide behavior and part of the pesticide is adsorbed onto soil. The main objective of this study was to determine the amount of diazinon adsorbed onto different soils in Upper Mahaweli River Catchment (UMRC) and also to determine the toxicological effects of diazinon on *Daphnia magna* and *Moina* species. Soil samples were collected from four locations in UMRC (UMRC1, UMRC2, UMRC3, UMRC4) and oven dried and sieved. Diazinon with known concentrations were added to the soil samples and kept 4 hrs in shaker for the adsorption. The non-adsorbed diazinon portion was extracted by solid phase extraction and the concentration was determined by gas chromatography with electron captured detector. For the toxicity test, diluted non-adsorbed diazinon solution was used. The 48 hr LC_{50} value of *Daphnia magna* and *Moina* species was determined by following the organization for economic co-operation and development guidelines. Highest diazinon adsorptions were reported in UMRC4 as 90.20% and 66.37% consecutively for 0.5 ppm and 1.0 ppm concentrations. For the 2.0 ppm concentration, the highest adsorption was given in UMRC2 as 96.50%. Diazinon adsorption by soil was significantly different with the soil total carbon content and the pesticide concentration ($P<$ 0.05). Both *Daphnia magna* and *Moina* species mortality percentages were significantly different with the diazinon concentration and the expose time at p=0.05. Highest LC_{50} value (48 hr) for *Daphnia magna* was reported in UMRC1. Highest LC_{50} value (48 hr) for *Moina* species were reported in both UMRC1 and UMRC2. As the considerable portion of diazinon is adsorbed by the soil, it may contaminate the environment due to desorption process.

Keywords: adsorption, chromatography, diazinon, toxicity, toxicology

**Corresponding author – email :deeptha.amarathunga@gmail.com*

Bioluminescence in Puttalam Lagoon of Sri Lanka

H.B.U.G.M. Wimalasiri[1,2]*, S.U.P. Jinadasa[1] and D.C.T. Dissanayake[2]

[1]*National Aquatic Resources Research and Development Agency (NARA), Crow Island, Colombo 15, Sri Lanka*

[2]*Department of Zoology, University of Sri Jayewardenepura, Gangodawila, Nugegoda, Sri Lanka*

Bioluminescence involves oxidation of Luciferin in conjunction with luciferase enzyme. This is a common and well studied phenomenon in marine environment. Bioluminescence in lagoons receives less attention compared to the marine bioluminescence. This study was conducted in order to find out the organism(s) exhibiting bioluminescence and factors favouring the proliferation of same in Puttalam Lagoon. Samples were obtained once a month in December 2016, February and March, 2017. Six sampling locations were selected in Puttalam Lagoon and sampling was done after sun set. Surface zooplankton samples were collected towing a plankton net horizontally with a mesh size of 180 µm and preserved in 5% buffered formalin. Bioluminescent zooplankton were identified using existing guides. Surface water samples were collected to determine nitrite, nitrate and orthophosphate levels in each location. Zooplankton abundance was estimated (ind./m^3) and was statistically related to nutrient data. Among the zooplankton species encountered, only two species (*Oikopleura dioica* and *Cypridina* sp.) were found to be bioluminescent. Nitrite content varied from 0.127± 0.02 mg/l to 0.412±0.071 mg/l. Nitrate content showed variation from 0.023±0.014 mg/l to 0.397±0.021 mg/l. Orthophosphate content varied from 0.039±0.014 mg/l to 0.134±0.013 mg/l. There was no significant relation of nutrient content with bioluminescence zooplankton abundance during the study period. Further studies are required to identify more bioluminescent species in Puttalam Lagoon and their spatial and temporal variation with physio-chemical parameters.

Keywords: bioluminescence, *Cypridina* sp., lagoon, nutrients

**Corresponding author – email :udeshikawimalasiri@nara.ac.lk*

Fauna associated with three seaweed types (*Padina antillarum*, *Cladophora herpestica* and *Gelidium* sp.) in Tangalle Beach, Sri Lanka

T.H.I.S. Hapuarachchi*, N.G.A.A. Subhashini and M.P. Kumara

Faculty of Fisheries and Marine Science, Ocean University of Sri Lanka, Mahawela Road, Tangalle, Sri Lanka

Five replicates of seaweeds namely *Padina antillarum*, *Cladophora herpestica* and *Gelidium* sp. were randomly selected from Tangalle Beach, Sri Lanka. Each seaweed was fully covered by a transparent polythene bag and the full individual was pulled out into a polythene bag along with the surrounding water for studying the seaweed associated fauna. Ninety-seven faunal types were found from the three seaweed types including isopods, nudibranchians, polychaets, copepods, Littorinidae, Foraminifera, Tubificidae, *Drupa granulata*, *Planaxis* sp., Amphipoda, Penaeidae post larvae, nematodes, *Calcinus*s sp., *Cerithiu mobeliscus*, *Ophiothrix* sp., scyphozoan larvae and marine crustaceans. The mean total animal abundance (MTAA) in unit volume of seaweed (1000 cm^{-3}) differed (p<0.05) between the species. *Cladophora herpestica* (983±510) had the highest MTAA per 1000 $cm^{-3}$of seaweed followed by *Gelidium* sp. (564.8±97.6) and *Padina antillarum* (194.7±178.1). The MTAA per gram (wet weight) of the three seaweed species did not differ (p>0.05). The MTAA per gram (dry weight) of the three seaweed species was significantly different (p<0.05) where *Padina antillarum* (150.9±60.5 g^{-1}) had the highest MTAA per gram followed by *Cladophora herpestica* (91.2±47.1g^{-1}) and *Gelidium* (59.45±21.05 g^{-1}). The median species diversity (MSD) Shannon H`in unit volume of seaweed (1000 cm^{-3}) was significantly different (Kruskal-Wallis, p<0.05) where *Gelidium* sp (5.97) had the highest MSD followed by *Cladophora herpestica* (3.10) and *Padina antillarum* (1.32). The MSD per gram (wet weight) of the three seaweed species was not different (Kruskal-Wallis, p<0.05). The MSD per gram (dry weight) of the three seaweed species was different (Kruskal-Wallis, p<0.05) where *Padina antillarum* (5.97) had the highest MSD followed by *Gelidium* (0.55) and *Cladophora herpestica* (0.27). The present research showed that the seaweed morphology such as bushy nature and densely growing nature of *Cladophora herpestica* the fan shaped thalli of *Padina antillarum* and the compact rhizoidal holdfast *Gelidium* could be the reasons for the MTAA and the MSD differences observed.

Keywords: abundance, associated fauna, seaweed

**Corresponding author – email :ishanishashikala5@gmail.com*

Heavy metal pollution in water and their effect on *Mugil cephalus* fish tissues at Negombo Estuary

B.R.C. Mendis[1]*, H.M.P. Kithsiri[1], M.M.M. Najim[2] and S.A.M. Azmy[1]

[1]*National Aquatic Resources Research and Development Agency (NARA), Crow Island, Colombo 15. Sri Lanka*

[2]*South Eastern University of Sri Lanka, Sammanthurai, Batticaloa*

Heavy metal pollution in aquatic environment has become major concern as a result of their non-biodegradable nature, long biological half-life and their potential to accumulate in different body parts of organism. The objective of this study was to determine the levels of selected five heavy metals viz, lead (Pb), cadmium (Cd), mercury (Hg), copper (Cu) and zinc (Zn) in water and fish tissues. The *Mugil cephalus* fish samples and water samples (n=60) were collected from Negombo Estuary at five sampling sites namely, Pitipana, Thaladuwa, Munnakkaraya, Katunayake, and Dandugam oya during the period from January to December 2016. The heavy metal concentrations in fish tissues and water were analyzed employing standard methods. The concentration of the metals in water were fluctuated within a range Pb, 12.1± 0.23 to70.4 ±13.0; Cd, 4.5±0.28 to 13.2±0.04; Hg, 2.0±0.01 to 5.0±0.29; Cu, 13.3±0.5 to 22.6±0.8 and Zn 360.2±98.3 to 460.1±132.0 µg L^{-1}. The results revealed that the concentration of metals (mg kg^{1}) Pb, Cd, Hg, Cu and Zn in fish tissues were 0.045±0.003 to 0.071±0.002; 0.035±0.001 to 0.04±0.004; 0.24±0.02 to 0.41±0.06; 0.35±0.05 to 0.378±0.06 and 3.32±0.32 to 5.82±0.54. It was observed that the concentrations of Pb, Cd, Hg, Cu and Zn in water were below the proposed tolerance limits for the discharges of industrial wastewater quality standards of Central Environmental Authority of Sri Lanka. Further, the concentration of Pb and Hg levels in fish tissues were exceeded the maximum recommended levels in food for human consumption specified by European Union standards limits. Hence, the Pb and Hg in *Mugil cephalus* fish tissue were comparatively high in Thaladuwa and Munnakkaraya sites and *Mugil cephalus*is not suitable for safe human consumption.

Keywords: Heavy metals, *Mugil cephalus*, Negombo Estuary

**Corresponding author – email :chani004@yahoo.com*

Preliminary study on ecology and possible threats of Upparu mangroves forest, Kinniya, Sri Lanka

P.A. Kushlani N Dissanayake[1,4]*, D.G.T.C. Balawardhana[2] and P.B. Terney P Kumara[3,4]

[1]*Department of Biology, Vrije Universiteit, Brussels, Belgium*

[2]*National Aquatic Resources Research and Development Agency (NARA), Crow Island, Colombo 15, Sri Lanka*

[3]*Marine Environment Protection Authority, Ministry of Mahaweli Development and Environment, Sri Lanka*

[4] *Department of Oceanography and Marine Geology, University of Ruhuna, Matara, Sri Lanka*

Mangroves are productive coastal ecosystems which provide numerous ecological and socio-economic benefits to all of its associates. At present, the growing demand for the land, resources and the dynamics of climate variability has threatened these environments locally as well as globally. Pollution by haphazard waste dumping has become a serious problem to mangrove ecosystems in many countries. In Sri Lanka, Upparu Lagoon in Trincomalee District is being used as a dumping site for several decades and reliable statistics and information are not available on the fauna and flora species composition and resource uses in the lagoon area. The study was conducted in January, 2014. True mangroves, mangrove associates and its associated inhabitants were identified and densities were estimated by deploying plots at selected sites. Focused group discussions and semi structured interviews were conducted to understand the prevailing issues and the local community linkages to the mangrove forest. A total of 32 respondents have participated by snowball sampling method. Seventeen (17) true mangroves, 07 mangrove associates, 19 birds, 8 molluscans, 7 butterflies and 5 crab species recorded in the study area. According to the socio-economic survey, resources were found heavily extracted for timber, construction material and firewood as well as in lagoon fisheries, livestock farming, and the lime industry. Combined effects of resource uses and garbage dumping had caused detrimental consequences to the community and biota leading to its environmental degradation. Therefore, immediate attention of relevant authorities is necessary to adopt site specific management interventions expecting the use of this valuable ecosystem in eco-friendly and sustainable manner.

Keywords: ecosystem, fauna and flora species, mangroves, Upparu Lagoon

**Corresponding author – email :kushlanidissanayake@gmail.com*

In vitro screening of antibacterial and photochemical properties of hot water spring cyanobacterium *Lyngbya* sp.

W.A.M.A. Wijesekara and Pathmalal M Manage

Department of Zoology, Center for the Algae and Water Quality, University of Sri Jayawardenepura, Gangodawila, Nugegoda, Sri Lanka

Cyanobacteria (blue-green algae) are rich sources of structurally novel and biologically active metabolites. Recent studies indicate the presence of some bioactive compounds in the blue green algae which are shown to exhibit anticancer, antimicrobial, antifungal or anti-inflammatory and other pharmacological activities. In the present study cyanobacterium *Lyngbya* sp. mat was collected from a hot water spring located from Nelumwewa (N 7.890686 E 81.199834) Sri Lanka. Extraction was carried out by hexane and methanol by standard methods. Antioxidant activity of methanol extracts were determined using DPPH (1,1-Diphenyl- 2- picrylhydrazyl) assay. The total phenolic and flavonoid content in the methanol extracts was determined using Folin-Ciocalteu reagent and aluminium chloride ($AlCl_3$) respectively where antibacterial activity of different concentration (40 mg/ml) of crude extract was carried out by disc diffusion and well diffusion methods against gram positive bacteria Methicillin-resistant *Staphylococcus aureus* (MRSA) ATCC 25923, *Bacillus* sp. and gram negative bacteria of *Salmonella typhii* and *Escherichia coli* ATCC 25922 respectively. Minimum inhibition concentration (MIC) was determined by TTC bio assay. Phycobilline protein was analyzed using freeze–thaw method. The highest total phenolic (238.48±0.01mg GAE/g extract) and flavonoid content (TFC) (202.53± 0.01 mg qua (quercetin) /g) was recorded in methanol crude extract. Highest free radical scavenging activity was found in the methanol extract (IC_{50}= 0.053 mg/ml) as well in the present study it was found that *Lyngbya* sp. contain only allophycocyanin which was 0.19 mg/l. The antibacterial activity of methanol extract was recorded against *Bacillus* sp., *E. coli* and *S. aureus* whereas antibacterial activity against *S. typhi* was not detected in both disc diffusion and well diffusion method. Highest antibacterial activity was recorded against *Bacillus* sp. in both disc and well diffusion method and the mean diameter of inhibition zone was around 36±2 mm disc method and 37 mm in well diffusion method in 40 mg/ml within 24 hrs. MIC in the methanol crude extract was 150 µg/ml against *S. aureus*. Thus, the result of the study showed that the *Lyngbya* sp. contained compounds which are potential for pharmaceutical invention and isolation of active ingredients from the crude extracts are being studied.

Keywords: antibacterial compounds, disc diffusion, *Lyngbya* sp., well diffusion

**Corresponding author – email :pathmalal@sjp.ac.lk*

Mangrove cover change detection in Vankalai bird sanctuary in Mannar District of Sri Lanka using Landsat satellite imageries

N. Thasarathan* and K. Suthakar

Department of Geography, University of Jaffna, Thirunelvely, Jaffna, Sri Lanka

Vankalai sanctuary, partly a wetland which was declared as one of the bird sanctuary by the Department of Wildlife Conservation (DWC) of Sri Lanka in 2008. The sanctuary is located adjacent to Mannar town covering 4839 ha. This sanctuary consists of several ecosystems such as arid-zone thorn scrubland, mangrove, salt marshes, lagoons and coastal grasslands. The objectives of this study are to identify the temporal changes of the mangrove covers and to understand the anthropogenic factors that have been influencing in the changes of mangroves from 1999 to 2017. Mangrove cover mapping have been carried out to the year of 1999, 2006, 2010 and 2017 using freely available Landsat satellite imageries. Mangrove area has been detected through the indices of normalized difference vegetation index (NDVI) in the remote sensing (RS) and geographical information system (GIS). After geometrically corrected, the images have been used to derive NDVI with the visible red and near infra red (NIR) bands in the remote sensing software of ERDAS Imagine 2014. Based on the NDVI values of each year the mangrove cover was estimated. Result of the analysis showed that, the mangrove cover has decreased in the Northwest and the middle part of the sanctuary. Significant amount of mangrove areas has been destroyed due to the illegal fishing and the mismanagement of mangrove between 2007 to 2009 periods. The total extent of mangrove cover was 6.5 km^2 in 1999 but this extent has decreased in 2006 and 2010 as 5 and 4.5 km^2 respectively. Results in 2017, indicated that the total extent of mangrove cover was 4.7 km^2. Therefore, proper monitoring and conservation programmes are needed to conserve the bird sanctuary in future.

Keywords: Landsat satellite, mangrove, NDVI, NIR

**Corresponding author – email :thasa.nada9@gmail.com*

Seasonal variation of heavy metals (Cd, Pb and Hg) in sediments and selected edible fish in the Puttalam Estuary, Sri Lanka

B. K. K. K. Jinadasa, Kasun R Dalpathadu*, T.B.D.T. Samaranayake and S. S. Gunasekara

National Aquatic Resources Research and Development Agency (NARA), Crow Island, Colombo 15, Sri Lanka

Seasonal variation of three heavy metals (Cd, Pb and Hg) in sediments and two fish species inhabiting in the Puttalam Estuary were studied to assess the heavy metal concentration in the sediments and biota. Data collection was carried out in 20 sampling points in February and September, 2016 in order to represent Northeast and Southwest monsoons, respectively. The laboratory analysis was carried out in accordance with standard methods. Results indicated that the average values of Hg, Pb and Cd in sediments were 0.0364, 0.002 and 0.00078 mg/kg during Northeast monsoon and 'Not Detected', 0.025, 2.43 mg/kg during Southwest monsoon respectively. No detectable concentrations of heavy metal were found in *Moolgarda seheli* while concentrations of 0.32 and 0.13 mg/kg of Hg were detected in *Plicofollis tenuispinis* during Northeast monsoon and Southwest monsoon respectively. As all the measured heavy metals in studied food fish are under the reference levels, it can be concluded that Cd, Pb and Hg concentrations in fish in the Puttalam Estuary are below the maximum allowable limits specified by the European Union for human consumption.

Keywords: fish, heavy metals, Puttalam Estuary, sediment

**Corresponding author – email :kasun.randika@yahoo.com*

Identification of spatial distribution of coral reef in Pigeon Island, Trincomalee by remotely sensed data

D.D.D. Weragodatenna[1]*, M.G.W.M.K. Gunarathne[2] and A.B.A.K. Gunaratne[1]

[1]*National Aquatic Resource Research and Development Agency (NARA), Crow Island, Colombo 15, Sri Lanka*

[2]*Green Planet Eco Consultant Ltd, Palawatta, Battaramulla*

Spatial distribution of important under water habitats is one of the key requirements for the decision makers on the resource management perspective. Therefore, extent and distribution pattern of coral reef yield valuable information to formulate environmental monitoring and management plan for the Pigeon Island Marine National Park where located at Trincomalee District. Wide distribution of coral reef ecosystem in the park and associated waters is significant to the environmental and economic wellbeing in the area. Capability of Geo-eye satellite image with 0.5 m spatial resolution to detect aquatic habitats of coral reef ecosystem was evaluated through three steps; image pre-processing, image classification and accuracy assessment using Environment for Visualizing Images (ENVI 5.0). Object orient classification method was applied to analyse the distribution of coral reef. Accuracy of the classification was obtained by an error matrix, which is attained 80%. The study area, from Uppuveli Lagoon to Vallaipunam in Kuchchaveli, Trincomalee encompasses a wide distribution of reefs including live coral and fringing reefs over shallow areas, between 1-10 m depth. Massive fringing corals are located in 100-200 m width mainly along the coastline in southern part of Pigeon Island, from Salli Amman to Marble Beach which is about 50 ha. The live coral reef is located in the Pigeon Island Marine National Park, around small and large Pigeon Islands and Coral Island where it is located northern side of the park. The extent of coral coverage in the National Park and coral island is 35 and 23 ha respectively. Most of the corals are located in shallow waters, as fringing reefs at depths of 2- 6 m.

Keywords: coral reef ecosystems, Geo-eye satellite images, Pigeon Island, remote sensing

**Corresponding author – email : dddilhari@gmail.com/dilhari@nara.ac.lk*

Presence of caryophylliid corals in biofouling community settled on artificial settlement collectors in Colombo Port

M. M. K. I. Marasinghe[1], R. R. M.K.P. Ranatunga[1]* and A.C. Anil [2]

[1]*Marine and Coastal Ecology Laboratory, Department of Zoology, Faculty of Applied Sciences, University of Sri Jayewardenepura, Sri Lanka*

[2]*National Institute of Oceanography, Dona-Paula, Goa, India*

Colombo Port is situated in the middle of East-West maritime route. Being one of the busiest port in Asia, Colombo Port is unreservedly exposed to marine bio-invasions. The present study was to investigate biofouling community within the port. Biofouling organisms were investigated from seven sampling locations using artificial settlement collectors. These collectors were submerged in four different depths where first set was 1 m below the water surface and others setting at 1 m intervals. Monthly samples were collected from October, 2014 to March, 2017. Fouling organisms were identified morphologically using fine morphological features and their percentage cover was also assessed. Three species of caryophylliid corals were recorded from five of the sampling locations (i.e. New Pilot Station; Colombo International Container Terminal; Passenger Jetty; Bandaranayke Quay; Unity Container Terminal within Colombo port. They are *Nomlandia californica, Paracyathus stokesii* and *Phyllangia americana* belonging to order Scleractinia, sub order Caryophylliina and family Caryophylliidae. They are small, encrusting and predominately do not show symbiotic relationship with algae. With continuous dredging, pollution and fresh water inputs, recruitment of corals in such a disturbed habitat is rare. Present findings indicated that their abundance of coral species within the Colombo Port is substantial. Therefore, it is necessary to implement management measures in these artificial environments to conserve coral species that are recruiting. Further, extensive work on coral recruitment within the port is imperative to understand their distribution and native or introduced status within the country waters.

Keywords: caryophylliid corals, Colombo Port, settlement collectors

**Corresponding author – email :ranatunga@sjp.ac.lk*

Assessment of current status of water quality in Madu Ganga Lagoon: A Ramsar Wetland in Sri Lanka

N.D. Hettige*, A.A.D. Amarathunga, S.R.C.N.K. Narangoda, M.D.S.R. Madduamge and K.A.W.S. Weerasekara

National Aquatic Resource Research and Development Agency (NARA), Crow Island, Colombo 15, Sri Lanka

The study was carried out at Maduganga to identify the present status of water quality since the lagoon is currently subjected to pollution due to various anthropogenic activities. Data were collected from February to November, 2016 on monthly basis by selecting thirteen random sampling locations. Dissolved Oxygen (DO), pH, water temperature, electrical conductivity (EC), salinity and turbidity values were recorded *in situ* and laboratory analysis were carried out using standard procedures. One-way ANOVA was used to determine significant differences between water quality parameters with sampling locations and time using MINITAB 14.0. Results indicated that, average DO and pH at surface and bottom were 5.07±0.48 mg/L, 4.73±0.72 mg/L and 7.37±0.33, 7.41±0.28 respectively. The average EC values were 15.30±3.24 mS/cm and 15.13±2.93 mS/cm at surface and bottom. Due to fresh water inputs and salt water intrusion to the lagoon, the salinity varied from 0-30 ppt. Turbidity of the lagoon water was higher at bottom than the surface. Average BOD of 16.04±4.89 mg/L and 16.69±5.63 mg/L were recorded at surface and bottom indicating organic and inorganic pollution of the water. Average surface ammoniacal-nitrogen (0.10±0.02 mg/L) was above the maximum recommended value (>0.94 mg/L) of the standards limits for fish and aquatic life and which may be possibly due to effluent discharges from various pollution sources from surroundings. Recorded average oil and grease content also was higher than the above standards limits (>10 mg/L). Oil and grease, pH and salinity values did not indicate significant differences (P>0.05) among the selected sampling locations and different months of the sampling period. However, proper management practices are needed to minimize further oil pollution and effluent discharges of the lagoon to avoid degradation of the lagoon.

Keywords: lagoon, pollution, sediment, wetland

**Corresponding author – email :nadeeshahettige7@gmail.com*

Small plastic debris in beach sand: A quantitative analysis with regards to beach usage

B.M.Y. Sathsara* and M.I.U. Manikarachchi

Faculty of fisheries and Marine science, Ocean University of Sri Lanka, Mahawela Road, Tangalle

Plastics that are brought in to beaches by different activities face weathering and fragmentation and brake down into small pieces, which easily incorporate with beach sands. The objective of this study was to quantify the small plastic debris (ranges between 0.5 to 5 mm) in the sand of four beaches, Pareiwella, Nilwella, Dickwella and Rekawa. Pareiwella is with recreational significance, while Nilwella is a popular fishing beach. Dickwella beach was selected as it runs a freshwater outlet to the sea. Rekawa beach was considered as the controller site since it is a protected area. Five random sand samples were collected using a 5 L bucket at each site and analyzed for small plastic debris. Each of the five samples at all sites was sieved using 3.15, 2.00, 1.00 and 0.5 mm meshed sieves. Retained debris in the sieves was separated into categories of plant, plastics and other. Collected plastic pieces were again categorized into 4 groups namely, foam, line, pellets and fragments. The average total weight and the average total abundance of plastic debris at each site were determined using a weighing scale and a light microscope respectively. The study was carried out on 11th of February for twelve hours. The average weights of small plastic debris in Pareiwella (0.646g±0.903), Rekawa (0.046g±0.0639), Nilwella (1.628g±2.228) and Dickwella (0.0640g±0.0631) were significantly different from each other (Kruskal-Wallis test; $p<0.05$). The average abundance of small plastic debris in Pareiwella (8.8±6.76), Rekawa (1.0±1.414), Nilwella (221.0±320) and Dickwella (23.2±11.3) were also significantly different (Kruskal-Wallis test; $p<0.05$). The highest abundance of small plastic debris was recorded in Nilwella, consisted of 51% foams, 24% line, 20% pellets and 4% fragments. The lowest was recorded in Rekawa which was consisted of 100% lines. The research concludes that the accumulation trends of small plastic debris vary according to the beach usage and management measures shall be specified accordingly.

Keywords: accumulation, beaches, small plastic debris

**Corresponding author – email :yasaminisathsara@gmail.com*

Water quality and microbial contamination status of Madawachchiya, Padaviya and Kebathigollewa areas in Anuradhapura District

M.G.Y.L. Mahagamage and Pathmalal M Manage*

Centre for Water quality and Algae Research, Department of Zoology, University of Sri Jayewardenepura, Gangodawila, Nugegoda, 10250, Sri Lanka

Typhoid or enteric fever is a worldwide infection caused by the bacterium *Salmonella enterica.* In Sri Lanka, 12,823 *Salmonella* positive cases were recorded and 133 cases were recorded from Anuradhapura District during 2005 to 2014. Therefore, the present study was carried out to identify the microbiological and chemical contamination status of eighteen water sources in Madawachchiya, Padaviya and Kebathigollewa during October, 2016. The study was focused to determine total coliform, faecal coliform, *Salmonella* sp. and *Shigella* sp. contamination along with some physico-chemical parameters of both ground and surface water. Sampling, transportation and analysis were performed following standard protocoles. Results of the study revealed that all sampling locations were contaminated with both total and faecal coliform bacteria and the values were not within the WHO and Sri Lanka drinking water quality standards. Around 50% of sampling locations were positive for *Salmonella* sp. and among them 2 spring sampling locations are being used to extract water for drinking. However, *Shigella* sp. was not recorded during the study period. Majority of the sampling points were recorded high COD values greater than the Sri Lanka drinking water quality standards (10 mg/L). The springs were recorded acidic pH values which were less than the WHO and SLS water quality standards. The electrical conductivity of two sampling locations was recorded greater than 750 µs/cm conductivity. The tested other water quality parameters; $N\text{-}NO_2^-$, $N\text{-}NH_3$ and total phosphate (TP) concentrations were found within the Sri Lanka drinking water quality standards. Principal component analysis revealed that sampling locations were grouped into three groups such as, well water, tank water and springs according to the water quality recorded during the study period.

Keywords: Anuradhapura, ground and surface water, *Salmonella* sp., *Shigella* sp., water quality

**Corresponding author – email :pathmalal@sjp.ac.lk*

Prevalence of CKDu in Medawachchiya area with special reference to the physical characteristics and source of drinking water

K.A.W.S. Weerasekara[1]*, A. Pathiratne[2] and H. M. P. Kithsiri[1]

[1]*National Aquatic Resource Research and Development Agency (NARA), Crow Island, Colombo 15, Sri Lanka*

[2]*Department of Zoology and Environmental Management, University of Kelaniya, Sri Lanka*

Chronic Kidney Disease of uncertain aetiology (CKDu) has been identified as a major health problem in some parts of the country, showing the highest prevalence in Medawachchiya. Previous studies have hypothesized the link of CKDu occurrence with the drinking water quality, however it was not characterized yet using physical characteristics of the drinking water sources viz. age of the well, dimensional measurements of the well etc; Hence, this study focused on examining potential association between the physical characteristics of the water resources with prevalence of CKDu in Medawachchiya Divisional Secretariat area. Current uses of drinking water sources of the study area were also assessed. Relevant data of households were obtained through field and questionnaire surveys from 2015 to 2016 for a total of 385 households (340 dug wells; 45 tube wells) which represented 20 Grama Niladhari divisions. Collected data were summarized for descriptive statistics using SPSS® 21. Results revealed that, around 90 % of the CKDu affected patients used water from dug wells. However, 52 % and 25 % of the people in the study area used filtered water for the source of drinking water and cooking respectively. Majority of them used either dug or tube well water for bathing and washing. It was also revealed that, the highest CKDu cases (62.9 %) recorded from the people those who used dug wells, which were dug during 1-25 years while 68.2 % of the records from the people who used dug wells around 6.40–9.15 m in depth showing possible contaminations of water resources in the study area since recent decades. Therefore, further studies needed to be carried out to evaluate biological significance of the contaminants and physicochemical characteristics of drinking waters to assess prevalence of CKDu with physical characteristics of selected drinking water sources located in the study area.

Keywords: chronic kidney disease, drinking water sources, dug wells, questionnaire survey, tube wells

**Corresponding author – email :shyamalikaww@nara.ac.lk*

Present status of sea turtle hatcheries situated along the coastal belt of the West and Southwest of Sri Lanka

R.A.M. Jayathilaka*, H.A.C.C. Perera and M.D.I.C. Kumara

National Aquatic Resources Research and Development Agency (NARA), Crow Island, Colombo 15, Sri Lanka

Collection of sea turtle eggs from the rookeries for human consumption and marketing eggs to the sea turtle hatcheries have been identified as major threats to the marine turtles in Sri Lanka. Normally, hatcheries receive the turtle eggs from the surrounding beaches, for *ex-situ* conservation activities and these eggs are reburied within the turtle hatcheries for incubation. Therefore, objectives of the present study were to assess the sea turtle hatcheries and to investigate the status of the sea turtle nesting beaches adjacent to the hatcheries. The study area was extended from the coastal stretch in two administrative districts, Colombo (Mount Lavinia to Rathmalana) and Galle (Benthota to Koggala). The information such as nesting beaches, sea turtle species, name of the egg collector, number of eggs buried, and date of eggs buried were collected from the each hatchery through data sheets. At the same time, direct observations were made by NARA research staff from January 2014 to December 2015. Totally fifteen operational sea turtle hatcheries were identified along the study areas. During the study period number of 208,053 (68.7%) green turtle eggs , 90,695 (30%) olive ridley turtle eggs, 1,442 (0.5%) hawksbill turtle eggs, 1,516 (0.5%) loggerhead turtle eggs and 1,010 (0.3%) leatherback turtle eggs were reburied inside the hatcheries. The maximum numbers of eggs reburied were reported during the period of December to May in each year. In addition relatively low numbers of eggs were reburied from June to October and the period of less number of eggs reburied was coincided with south-west monsoon. Furthermore, a total number of 3,354 nesting and 368,835 number of eggs production were estimated in the study area. Around 82% of the total number of eggs was incubated under the hatchery conditions. The study revealed that the practices in egg collection, transportation, and reburying, rearing and releasing hatchlings comprise considerable negative impacts on the survival of the wild turtle stocks. Also, inappropriate rotations and movements of eggs may cause damages to the development of embryonic membranes and change the natural sex ratio. Capacity building of interested parties through proper trainings in each activity is needed to minimize the mortality rates and other negative impacts on wild marine turtles.

Keywords: *ex-situ* conservation, in-situ nest protection, reburied, nesting, sea turtle hatchery

**Corresponding author – email :ramjayathilaka@yahoo.com*

Aquatic Post Harvest Technology

Dietary intake of total mercury through yellowfin tuna and swordfish; a case study; Gampaha District in Sri Lanka, 2016

G.D.T.M. Jayasinghe*, B.K.K.K. Jinadasa and K.P.G.L Sandaruwan

National Aquatic Resources Research & Development Agency (NARA), Crow Island, Colombo 15, Sri Lanka

Total mercury (T-Hg) concentrations in fish from cooking effects were investigated in Gampaha District, Sri Lanka. The two large pelagic fish species which are most commonly consumed, yellowfin tuna (YFT, n=11) and swordfish (SF, n=11) were used in the present study. This study was done based on the "Total Diet Study (TDS) approach" introduced by the World Health Organization (WHO). The cooking techniques were comprised with utensils (aluminium and clay pots, 2:9), energy source (gas and firewood, 5:6) and cooking methods (chili curry, milk curry and ambulthial, 3:6:2). Total mercury concentration was determined before and after cooking by using microwave digestion and cold vapour atomic absorption spectroscopy (CV-AAS). The average T-Hg concentrations of flesh YFT and SF before cooking were 0.41and 0.86 mg/kg and 0.27 and 0.76 mg/kg after cooking. Data was analyzed by using Microsoft excel and SPSS software. The concentrations of T-Hg were not significantly different in the flesh fish before and after cooking. The data obtained from the TDS surveys, the average consumption of these fishes were 301 g per week. The provisional tolerable weekly intake (PTWI) suggested by the World Health Organization for total mercury (4 µg/kg bw per week) was calculated the average body weight person (50 kg). The percentage contribution of PTWI for T-Hg from YFT and SF were 41 and 114 respectively. Hence, consume the SF, might put consumers at potential risk of Hg poisoning.

Keywords: provisional tolerable weekly intake, total diet study, total mercury

**Corresponding author – email :thilini.madurangika123@gmail.com*

Investigation of modified method to increase degree of deacetylation of chitin polymer extracted from shrimp shell waste

S. Thiruchenduran*, G. J. Ganegama Arachchi, D. S. Ariyarathne, T. P. Hemachandra and M. R. Perera

National Aquatic Resources Research and Development Agency (NARA), Crow Island, Colombo 15, Sri Lanka

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.

Keywords: chitosan, degree of deacetylation, fat binding capacity, water binding capacity

**Corresponding author – email : Thiruchenduran.s@gmail.com*

Production of silage from fish waste using whey as the inoculum

H.G.P. Sameera[1]*, K.W.S. Ariyawansa[2] and B.E.P. Mendis [1]

[1]*Department of Food Science and Technology, Faculty of Agriculture, University of Peradeniya*

[2]*National Aquatic Resources Research & Development Agency (NARA), Crow Island, Colombo 15, Sri Lanka*

The fisheries industry plays an important role in the economy of Sri Lanka by providing livelihood mainly for coastal communities. In 2015, the total fish production was recorded as 520,190 Metric tons. During fish processing, a large amount of wastes are produced and fish waste management has become one of the problems having the greatest impact on the environment. One potential way of minimizing these problems is its transformation into a product to be incorporated as an ingredient in animal rations. Fish silage which frequently added into animal feed is a liquid or semi-solid product made from whole fish or parts of fish that are liquefied by the action of enzymes in the fish in the presence of an added acid. This study was carried out to produce fish silage from fish waste through a biological process involving microbial fermentation. The whole experiment concentrated on developing an ensilation formula and determining a time frame to get a physically (consisting good odour, colour, texture and uniformity), biologically (no any harmful microorganisms in considerable level), and nutritionally (containing higher protein content) better quality final product, where whey uses as the lactic acid bacterial inoculum and molasses as the fermentable carbohydrate source. The combination of 6% of whey, 15% of molasses and 79% of fish viscera waste was the best formula and 5 day time period was selected as the best fermentation period. The results of the analysis of proximate composition indicated 14.52±0.05 % of protein content in the final silage product and the respective nitrogen amount is appropriate to be used as a supplement for animal feed production.

Keywords: fermentation, fisheries sector, fish silage

**Corresponding author – email : pathumhgps@gmail.com*

The effect of olive oil as a poaching medium for triggerfish (*Canthidermis maculata*) on shelf life and the sensory acceptability

R. Lashanthini*, W. W. Rukshan and N. P. G. Pushpitha

Faculty of Fisheries and Marine Sciences, Ocean University of Sri Lanka, Mahawela Road, Tangalle

Olive oil is a more healthy and nutritious oil as an essential constituent inexpensive food recipes in the world. Fish poaching in olive oil is a gentle cooking method that increases the food quality and also extends the shelf life. Triggerfishes (*Canthidermis maculata*) are an abundant fish in Sri Lanka, but low demand with the local recipes. Olive oil was used to improve sensory quality and anti-microbiology of triggerfish chunks stored at 32±2 °C. Smaller chunks were oven poached at 105 °C for 15 minutes (water-poached and olive-poached) and aseptically kept immersed in that of each 20 mL of olive oil and water. Three triggerfish chunks of each medium were homogenized and suspended at regular time intervals (0, 36th hr and 72nd hr) and serial dilutions were performed for total plate counts (TPC). The sensory acceptability evaluations were carried out by 20 untrained panelists with the nine points hedonic scale (1-poor to 9-excellent) for appearance, odor, texture and taste of the fish poaching in olive oil. Olive-Poached triggerfish chunks at 36th hr and 72nd hr showed a slight reduction (p>0.05; two sample t-tests) in TPC (and) than in water-poached chunks (log CFU/g and) at the same times. The mean sensory acceptability scores of olive-poached triggerfish chunks (36th hr) in respect of appearance, odor and texture were significantly higher (p<0.05) than in water-poached triggerfish chunks. The olive- poached triggerfish chunks also demonstrated the positive effect on shelf life extension while stabilizing the quality. These may increase the value addition for triggerfish products.

Keywords: olive oil, sensory acceptability, total plate count, triggerfish

**Corresponding author – email :lashanthinirajendram@gmail.com*

Assessment of microbiological quality of oysters (*Crassostrea madrasensis*) harvested in different locations of Puttalam Lagoon in Sri Lanka

K.W.S. Ariyawansa*, S. Gallage, P. Ginigaddarage, K. Hettiarachchi, G.P. Roshan, C. Madagedara and H.M.P. Kithsiri

National Aquatic Resources Research & Development Agency (NARA), Crow Island, Colombo 15, Sri Lanka

At present bivalve farming in Sri Lanka is at early stages and there is a great potential for development of bivalve culturing as an industry for local and export markets. Puttalam Lagoon has been identified as one of potential sites for farming of oysters (*Crassostrea madrasensis*) which has high demand over other edible bivalves. Oysters are filter feeders and able to ingest particles in suspension that may carry pathogenic microorganisms. This may pose a health risk to consumers when oysters are consumed in raw. The aim of the study was to evaluate the microbiological quality of oysters and lagoon water from respective oyster growing sites, including Kalpitiya, Kandakuliya, Anaiwasal, Janasawipura and Gangewadiya in Puttalam District. In 2016 and early 2017, 100 of oysters and 42 of lagoon water samples were collected and analysed for total bacterial count (TBC), coliform, faecal coliform, *Escherichia coli*, *Salmonella* sp., *Vibrio cholerae* and *Vibrio parahemoliyticus*. TBC of oyster samples ranged from 10^3- 10^7 CFU/g and 88% of samples had less than 5 x 10^5 CFU/g. Of the 100 oyster samples, 86% and 77% of samples remained contaminated with coliforms and faecal coliforms, respectively, at acceptable levels. *E. coli* were detected only in 60% of oyster samples while unacceptable levels (>2.3 MPN/g) were detected in 39% of these samples. *Vibrio cholerae* and *V. parahemoliyticus* were absent in all oyster and water samples. Of all samples tested, one oyster sample and one water sample were contaminated with *Salmonella* sp.. TBC of water samples were in the range of 5.0 x10^1 – 7.0 x10^5 CFU/mL. About 21 and 26% of water samples were free from coliforms and *E.coli* respectively, while rest of the samples were contaminated with coliforms, faecal coliforms and *E.coli* in the range of 1 to >1800 MPN/100 mL. According to current microbiological quality of oysters and lagoon water, harvesting areas studied can be classified as class "B" based on European shellfish harvesting area classification criteria. The present study also revealed that microbiological quality of harvested oysters and growing water is unacceptable in some instances and the need of depuration of oysters before consumption as raw product or cooking by approved methods.

Keywords: depuration, filter feeding, microbiological quality, oysters

**Corresponding author – email :sujeewa@nara.ac.lk / sariyawansa@hotmail.com*

Investigation of pathogenic bacterial contaminations of fish handled in Mannar, Sri Lanka

Mekhala Ratnayake[1], P.H. Ginigaddarage[2]*, G.J. Ganegama Arachchi[2], K.W.S. Ariyawansa[2], Indira Wickramasinghe[1], K.S. Hettiarachchi[2], S. Abhayarathne[2], G.P. Roshan[2], G. Gunasekare[2] and S. Gallage[2]

[1]*Department of Food Science and Technology, Faculty of Applied Sciences, University of Sri Jayewardenepura, Gangodawila, Nugegoda, Sri Lanka*

[2]*National Aquatic Resources Research & Development Agency (NARA), Crow Island Colombo 15, Sri Lanka*

About 19,000 Metric tons of marine fish is produced in Mannar annually and information on current microbiological quality of fish produced in Mannar is not adequate. Therefore, the present study investigated into the pathogenic bacteria in fish and sources of contamination of fish during the period from May to September in 2016. This study assessed faecal coliform, *Escherichia coli* (*E.coli)*, and *Salmonella* in 14 fish samples from one day boats, 12 samples from fish collecting sheds (Wadiya) by the lagoon, 11 samples of lagoon water used for washing of fish, 9 ice samples used for chilling of fish at Wadiya, 19 swab samples from fish holds of boats and 7 swab samples from floors of Wadiya. About 54% of fish collected from both boat and Wadiya (14/26) contained *E.coli* in the range of 0.36–460 MPN/g whereas *Salmonella* sp. was present in 7% (1/14) of fish obtained from boats alone. Lagoon water samples and ice samples obtained from Wadiya were highly contaminated with *E.coli* having MPN numbers ranging from 350 to 5500 and from 20 to >18000 MPN/100 mL respectively. *Salmonella* sp. was present in 11% (1/9) of ice samples. The population level of *E.coli* in swabs obtained in fish hold of boats and Wadiya ranged from 5 to >1800 and from 350 to >1800 MPN/cm^2, respectively. *Salmonella* sp. was absent in both Wadiya and boats. Results of the present study showed that fish landed at fish landing sites in Mannar were contaminated with pathogenic bacteria such as *Salmonella* sp. High faecal contaminations as mentioned above existed in main utilities used in fish handling such as lagoon water and ice showing the need for supply of good quality water and ice while pathogenic bacterial contaminations on the surfaces of boats and Wadiya indicate the need for adopting better sanitation procedures such as use of sanitizers to clean fish contacting surfaces at fish landing sites in Mannar.

Keywords: *Escherichia coli*, faecal coliform, fish, Mannar, *Salmonella* sp.

**Corresponding author – email : hasangi_g@yahoo.com*

Fatty acid profiles of Malabar sprat (*Ehirava fluviatilis*) from brackish water and fresh water habitats in Sri Lanka

H. K. S. de Zoysa*, E. M. R. K. B. Edirisinghe and T. V. Sundarabarathy

Faculty of Applied Sciences, Rajarata University of Sri Lanka, Mihintale, Sri Lanka

Malabar sprat (*Ehirava fluviatilis*) is a small clupeid of marine origin found in marine, brackish water and freshwater habitats in Sri Lanka. This species is reported to be found in two inland reservoirs namely; Rajanganaya and Parakrama Samudra. The restricted distribution of this species in inland waters was hypothesized to be due to the species has to rely on food containing essential fatty acids. The main objective of this study was to investigate the fatty acid profiles of the flesh and the gut content of *E. fluviatilis* in relation to the two habitats. This study was conducted to cover the wet and dry seasons and the sampling was done in Bolgoda Lake and Rajanganaya reservoir. Bligh and Dyer method was used to extract the lipids and fatty acid profiles were analyzed by gas chromatography. The gut analysis was also performed from the sampled fish. The results showed that fatty acid C18:2 (n-4) was only recorded from the flesh of *E. fluviatilis*, from the Rajanganaya reservoir. The fatty acids C14:0, C15:0, C20:5 (n-3), C22:4 (n-6) and C22:5 (n-3) were predominant in fish collected from the Bolgoda Lake and C14:0, C16:1 (n-7), C16:2 (n-4), C18:1 (n-9), C18:1 (n-7), C22:5 (n-3) and C22:6 (n-3) were the predominant fatty acids recorded in fish sampled from the Rajanganaya reservoir. The guts analyses revealed that *E. fluviatilis* from both habitats had similar food preference having copepods, cladocerans and rotifers in their diets. High copepod abundance was also recorded from the Bolgoda Lake population. As such, it can be postulated from the results of the present study that *E. fluviatilis* obtains essential fatty acids from their food sources. The current study also revealed that C18:2 (n-4) would has been synthesised by *E. fluviatilis* population in Rajanganaya reservoir.

Keywords: Bolgoda Lake, clupeids, colonization, Rajanganaya, Sri Lanka

**Corresponding author – email :dezoysahks@yahoo.com*

Investigation of histamine in *Katsuwonu spelamis* (skipjack tuna) harvested by multi-day boats using a rapid colourimetric method

G.M.T.E. Jayaratne[1], G.J. Ganegama Arachchi[2]*, A.A.D. Amarathunga[2], Ruchitha Perera[2], and I. Wickramasinghe[1]

[1]*Department of Food Science and Technology, Faculty of Applied Sciences, University of Sri Jayewardenepura, Nugegoda, Sri Lanka*

[2]*National Aquatic Resources Research and Development Agency (NARA), Crow Island, Colombo 15, Sri Lanka*

Histamine, a biogenic amine is a chemical hazard in fish and histamine food poisoning is found to be associated with high level consumption of scombroid fish, such as skipjack tuna. The present study tries to investigate the histamine levels in skipjack tuna by using a gravimetric and colourimetric methods, as simple and rapid methods. Skipjack tuna in the present study was obtained from three different markets. These methods were validated in terms of accuracy, repeatability, linearity and range of determinations. Linearity of histamine concentration determinations were range from 0.5-300 µg/mL with a correlation coefficient (R^2) of 0.9997. The recovery of histamine determination was 81.79% and demonstrated no significant difference between the percentage recoveries obtained at different histamine levels ($p< 0.05$). The repeatability of histamine determinations were less than 2% of the relative standard deviation (RSD). These methods were demonstrated the valid histamine determination in skipjack tuna and relied for routine analysis. Among the tested skipjack tuna samples, 86% were positive for histamine concentrations. The skipjack tuna samples were significantly different in histamine concentrations between Peliyagoda fish market, retail fish market and the Negombo fish market. The highest histamine concentration (>180 ppm) was in the skipjack tuna from Negombo. The lower defect action level of 50 ppm was observed in skipjack tuna from Peliyagoda fish market (91.6%) and 83% from retail fish market. The higher defect action level was observed in all skipjack tuna samples from Negombo.

Keywords: colourimetric method, gravimetric method, histamine determination, skipjack tuna, scombroid fish

**Corresponding author- email: arachchi.geevika@nara.ac.lk*

Quality assessment of *Decapterus russelli* (Indian scad) fish harvested by multi-day boats in Kudawella and Puranawella in Sri Lanka

T.H.T. Madhushani Thusi[1], G.J. Ganegama Arachchi[2]*, P.H. Ginigaddarage[2], K.W.S. Ariyawansa[2], Indira Wickramasinghe[1], K.S. Hettiarachchi[2], S. Abhayarathne[2], G.P. Roshan[2], G. Gunasekare[2] and Fathima Nizreena[2]

[1]*Department of Food Science and Technology, Faculty of Applied Sciences,University of Sri Jayewardenepura, Gangodawila, Nugegoda, Sri Lanka*

[2]*National Aquatic Resources Research and Development Agency (NARA), Crow Island, Colombo 15, Sri Lanka*

This study assessed the post harvest quality losses (PHQL) in Indian scad fish (*Decapterus russelli)* stored in fish holds of multi-day boats (MDBs) with ice and sea water in Southern coast. Altogether, 43 fish, 09 water and 07 ice samples were analysed from May to August in 2016. Fish were analyzed for total volatile base nitrogen (TVB-N), salt content (dry w/w %), total plate counts (TPC), *Escherichia coli (E.coli)*, and *Salmonella* species. Sea water in harbour basin and ice used in MDBs were also analyzed for *E. coli* and *Salmonella.* Fish were categorized into 4 groups according to sensory evaluation as good (Gd-I), fair (Gd-II), poor (Gd-III) and bad (Gd-IV). The PHQL of Indian scad fish increased with the trip duration of MDBs. The percentage of PHQL of Indian scad fish in MDBs were 22%, 28% and 35% for trip durations <10, 10–19 and >20 days, respectively. The average of TVB-N in Indian scad fish were 21.2, 28.4, 27.5 and 35.7 mgN/100 g, distributed in Gd-I, Gd-II, Gd-III and Gd-IV groups, respectively. The average ranges of salt contents were 0.8–1.8, 0.9-1.6, 1.1-1.9, and 1.2-2.1%, distributed in Gd-I, Gd-II, Gd-III and Gd-IV groups, respectively. Fish belong to Grade I, II, III and Grade IV contained TPC in the range of $1.9 \times 10^4 – 9.5 \times 10^6$, $1.9 \times 10^4 – 2.3 \times 10^7$, $2.0 \times 10^4 – 3.0 \times 10^7$ and $5.0 \times 10^5 – 8.1 \times 10^6$ CFU/g, respectively. The percentages of *E.coli* detection were 46%, 54%, 77% and 50% in Gd-I, Gd-II, Gd-III and Gd-IV groups, respectively. Total *E.coli* contamination was 42% (18/43) and *Salmonella* sp. contamination was detected in Gd-II and Gd-III in three occasions. Sea water from Kudawella and Puranawella harbour basin showed high levels of *E. coli* contamination. Twenty five percentage of ice from Kudawella harbour were contaminated with *Salmonella* sp. and high levels of *E.coli.* Results of this study indicated that high levels of contaminations of fish with faecal origin pathogenic bacteria may have occurred through use of contaminated ice and harbour water in boats and upon unloading of fish at the pier in the harbour.

Keywords: Indian scad fish*, E.coli, Salmonella,* salt content, total volatile base nitrogen, total plate counts

**Corresponding author- email: arachchi.geevika@nara.ac.lk*

Isolation and characterization of collagen from yellowfin tuna (*Thunnus albacares*) waste

K.W.S. Ariyawansa[1]*, D.S. Ariyaratne[1], M. J. Paththuwe Arachchi[1], G.S. Chaturika[1], Mudhitha Senerath Yapa[2] and Chathuri Yatawara[2]

[1]*National Aquatic Resources Research & Development Agency (NARA), Crow Island, Colombo 15, Sri Lanka*

[2]*John Keells Holdings, Colombo 02, Sri Lanka*

Yellowfin tuna is the most popular fish variety processed for the export market in Sri Lanka and generates a significant amount of discards during processing. These yellowfin tuna discards which are of high quality can be used as a raw material for other valuable products. Use of waste as a source of collagen can impact on fish waste management with high economic returns. The aim of the study was to use yellowfin tuna skin, fin and bones for the extraction of collagen. Acid soluble collagen (ASC) and pepsin soluble collagen (PSC) was extracted from yellowfin tuna fish skin, bones and fins using the methods of Nagai and Suzuki (2000) with slight modifications. The yields of collagens from skin, bones and the fin of yellowfin tuna were 21%, 0.89% and 1.22%, respectively. Extracted collagen was characterized using amino acid analysis, SDS-PAGE analysis and fourier transform infrared spectroscopy (FTIR). Amino acid composition of the extracted collagen confirms the purity of collagen. Glycine was the most abundant amino acid identified in the skin, bone and fins of yellowfin tuna. Relatively high amount of glutamic acid, arginine, alanine and lysine was observed where as cystine was not detected. Similar band patterns were recorded for both extracted collagen and human collagen type-1 which composed of α1, α2 and β chain indicating the higher quality of extracted collagen. Fourier transform infrared spectroscopy proved that ASC and PSC are integrated and native. The infrared spectra of ASC, PSC and the major peaks with their corresponding results confirmed the helical structure of the collagen which is reserved in good condition. High grade collagen with high yield could be extracted using yellowfin tuna skin generated from export fish processing industry successfully in Sri Lanka.

Keywords: collagen, fish waste, FTIR, SDS-PAGE, yellowfin tuna

**Corresponding author- email: sujeewa@nara.ac.lk, sariyawansa@hotmail.com*

Quality assessment of imported fish retailed in Sri Lanka

P.G. Madusha Dilrukshi[1], G.J. Ganegama Arachchi[2]*, P. H. Ginigaddarage[2], K.W.S. Ariyawansa[2], I. Wickramasinghe[1], K.S. Hettiarachchi[2], S. Abhayarathne[2] and Ruchitha Perera[2]

[1]*Department of Food Science and Technology, University of Sri Jayewardenepura, Sri Lanka*

[2]*National Aquatic Resources Research and Development Agency (NARA), Crow Island, Colombo 15, Sri Lanka*

The present study assessed the quality of selected varieties of imported fish by testing the concentration of formaldehyde, total volatile basic nitrogen (TVB-N) content and *Escherichia coli* (*E.coli*).The samples included four of Indo-Pacific sailfish (*Istiophorus platypterus*), five of blue mackerel *(Scomberaus tralasicus*), nine of bullet tuna *(Auxis rochei*), seven of sword fish *(Xiphias gladius*), seven of squids *(Loligodu vauceli*) and four of Indian Scad *(Decapterus russelli*) available in retail outlets in Gampaha District in Sri Lanka. Formaldehyde content was assessed only in sword fish, squids, Indian scad and bullet tuna species and showed values in the range of 0.917 to 3.34 mg/kg. There was a significant difference ($p<0.05$) between the mean formaldehyde concentrations of swordfish and bullet tuna. All fish samples revealed formaldehyde concentration lower than specified limit of 5 mg/kg (Food Regulation No. 1646/19: Formaldehyde in fish, 2010). Mean TVB-N content of bullet tuna, squids, Indo-Pacific sail fish, sword fish, blue mackerel and Indian scad were 36.00, 6.65, 9.00, 20.60, 10.82 and 137.4 mg/100g, respectively and the mean values of these fish varieties were significantly different each other ($p<0.05$). Majority of the imported fish samples (27/36) had *E. coli* levels of good quality (75.76%) according to ICMSF (1986) standards while the remaining fish (9/36) were marginally acceptable (24.24%).

Keywords: *E. coli,* formaldehyde, imported fish, total volatile basic nitrogen

**Corresponding author- email: arachchi.geevika@nara.ac.lk*

Characterization of chitosan nanoparticles and evaluation of antimicrobial activity

S.Thiruchenduran*, T.N.V.K.V. Prasad and N.Supraja

Nanotechnology Laboratory, Institute of Frontier Technology, Regional Agricultural Research Station, Acharya N G Ranga Agricultural University, Tirupati, India

Nanoparticles derived from chitosan have become a widely utilized material in biological experiments as an antimicrobial agent. Their application in food and health industries is also under rigorous investigation. The objective of this study was to synthesize chitosan nanoparticles (CNPs) from shrimp shell chitosan, characterize the particles and their stability and to investigate the CNPs antimicrobial activity against selected strains of fungal and bacterial species. Characterization of the CNPs was done using surface plasmon resonance activity, zeta potential analysis and particle size distribution analysis. Disk diffusion method was employed to analyze the antimicrobial activity of the CNPs. The synthesized CNPs showed good stability with 52.3 mV at 25.1 °C with a conductivity of 0.127 mS/cm. The mean particle size was 32.2 nm at 90° scattering angle under monodisperse form. Stable CNPs showed significant (p<0.05) antimicrobial activity against *Streptomyces* sp., *Pseudomonas fluorescence Staphylococcus aureus, Aspergillus niger* and *Aspergillus flavus*. It is concluded that stable nanoparticles can be synthesized from shrimp shell chitosan and effectively used as antimicrobial agents.

Keywords: antimicrobial activity, chitosan, nanoparticles,

**Corresponding author- email: Thiruchenduran.s@gmail.com*

Dietary fiber content, fatty acid and starch digestible rate of seaweed and seaweed based products in Sri Lanka

P.S. Jayasinghe[1]*, V. Pahalawattaarachchi[1], K.K.D. S. Ranaweera[2] and R. Perera[1]

[1]*National Aquatic Resources Research and Development Agency (NARA), Crow Island, Colombo 15, Sri Lanka*

[2] *Faculty of Food Science and Technology, University of Sri Jayewardenepura, Gangodawila, Nugegoda*

Seaweeds are marine algae rich with nutrients which played vital role in food industry. The diets rich in fiber and nutrients in marine algae and based products have positive effects on human health. The focus of this study was to evaluate the total dietary fiber (TDF) and fatty acids profiles (FA) in five native seaweed species, some extracts and prepared products. TDF analysis of the seaweeds were conducted by enzymatic digestion methods while fatty acids were analyzed by gas chromatography method. In addition *in vitro* starch digestibility rate was also determined in seaweed based vegetable soup samples compared to commercial soup. The TDF contents of *Sargassum species*, *Ulva reticulate* and *Ulva lactuca Grcilaria verrucosa* and *Kapphaphycus alverazii* found 77%, 70%, 66%, 59% and 46% respectively. The seaweed extracted polysaccharides agar, carrageenan and alginic acid were also reported higher TDF values 77%, 74% and 73% respectively. The TDF values of seaweed incorporate three products *Ulva* and agar mixed vegetable soup, *Ulva* jam and agar added fruit jams (replace pectin) were ;45%, 58%, and 40% respectively and lower compared to others. Fatty acid profile of *Gracilaria verrucosa* consisted of nine types (60%) of saturated fatty acids (SAFA), three types of (20%) mono unsaturated fatty acids (MUFA) and five types (5.8%) of polyunsaturated fatty acids (PUFA). The starch digestibility rate of seaweed mixed soup recorded half of the record that of commercial soup. The five seaweed species and related products were found to be rich sources of dietary fiber, and valuable source of poly unsaturated fatty acids with and n-6 FA and n-3 FA ratio at 1. This ratio recommended by World Health Organization to be less than 10 in order to prevent inflammatory, cardiovascular and nervous disorders in human body

Keywords: dietary fiber, unsaturated fatty acids, seaweeds, polysaccharides, digestibility

**Corresponding author- email: Pradee_jaya@yahoo.com*

Fisheries, Socio-Economics and Marketing

Socio-economic and livelihood aspects of fisheries in Panama Lagoon of Sri Lanka

D.W.L.U. De Silva*, H.D. Wimalasena, K.P.G.L. Sandaruwan and K.H.M.L. Amaralal

National Aquatic Resources Research and Development Agency (NARA), Crow Island, Colombo 15, Sri Lanka

This study was conducted to explore the socio-economic and livelihood aspects of the fisheries in Panama Lagoon located in Lahugala Divisional Secretariat of Ampara District from January to June in 2016. Total of 32 fishers were sampled based on convenience sampling and subjected to the direct interviews to collect data and relevant information using a pre tested semi structured questionnaire. According to the results, 53% of fishers were belong to 45-64 age category and the majority of fishers (53%) had only the primary education. Both male and female were engaged in fishing activities in this lagoon. On average, a fisherman engages 23 days in fishing per month in lagoon fisheries throughout the year where as a fisher woman engages 20 days in fishing during the prawn season. Only the non-motorized traditional boats were in fishing operation. Drift gill nets and cast nets were the most commonly used fishing gears in Panama Lagoon. The study reveals that the average daily fish catch per craft was 4 kg and the monthly average fishing income of a fisherman was Rs. 29,049.00. A fisher woman earned Rs. 412.00 per day by picking up 750 g of prawns per day on average. During the prawn season a fisher woman earned Rs. 8,240.00 per month. The average annual maintenance cost and replacement investment of fishing operation in Panama Lagoon fishery was Rs. 19,213.00 and 48,532.00 respectively.

Keywords: fisheries, livelihood, Panama Lagoon, socio-economic aspects, Sri Lanka

**Corresponding author – email :lasamiupsala@gmail.com*

An insight into livelihood aspects of Puttalam Lagoon fishery

M.M.A.S. Maheepala*, D.W.L.U. De. Silva, K.P.G.L. Sandaruwan and K.H.M.L. Amaralal

National Aquatic Resources Research and Development Agency (NARA), Crow Island, Colombo 15

Puttlum Lagoon is located in the North-western Province and approximately 3,2700 ha in extent. Out of the total estimated lagoon fishers, 5,500 and 450 were full time and part time fishers respectively. The objective of the study was to find out socio-economic and marketing status of the lagoon fishers. The data were collected using structured questionnaire during 2016 and stratified random sampling technique was used to collect data selecting each fisheries inspectors' division and each craft type of the lagoon. It was found that majority of fishers (58%) have more than 20 years of experience in fishing. The average monthly incomes per fisher who use OFRP, MTRB and NTRB crafts were Rs. 37,548.00, 29,150.00 and 25,117.00 respectively. Shrimp and crab nets are the major fishing gears used in the lagoon. The average incomes per day per fisher of a fishing trip of shrimp and crabs were Rs. 1800.00 and 1700.00 respectively. One-way ANOVA confirmed that there were significant mean differences of the income of fishers use OFRP, MTRB and NTRB crafts (p<0.05). There were close linkages between lagoon fishers and fish buyers. Fish buyers provide fishing equipment and other day to day fisher needs and in turn fishers dispose his catch to the respective buyer. Fishers perceive that the government involvement in the lagoon fishery management is very low. According to fishers (43%), the fyke net (kudu nets) is highly destructive fishing gear which destroys juvenile stages of fish and shell fish species of the lagoon. It is recommended to implementation of the fishery management plan established under 1772/29 Gazette with the fisher's participation to minimize the negative impacts of destructive fishing practices. Well functioned fishery management plan will secure fishers' welfare as well as the lagoon environment.

Keywords: economic status, lagoon fishery, social status

**Corresponding author – email : mmasmaheepala@yahoo.com*

Socio-economic aspects of indirect fishery workers with special reference to Negombo Fisheries District in Sri Lanka

H.D. Wimalasena*, D.W.L.U. De Silva and K.P.G.L. Sandaruwan

National Aquatic Resources Research and Development Agency (NARA), Crow Island, Colombo 15, Sri Lanka

This paper reviews the socio-economic aspects of indirect fishery workers (IFWs) in the Negombo Fisheries District. Indirect fishery workers provide supporting services to fishers from pre-production to post production stages until fish and fishery product reaching the consumer. Data collected using semi-structured questionnaire from 139 indirect fishery workers from March to September, 2016. The gender divide of indirect fishery workers was confined to male and female by 79 and 21% respectively. Six percent (6%) of them never attended school. Primary and secondary education was achieved by 32 and 62% of IFWs respectively. The mean monthly income of indirect fishery workers was in the range of Rs. 15,000.00-53,000.00 depending on the type of activity. The highest monthly income was earned by engaging in fish retail marketing followed by dried fish making. Fuel supply for boats, net mending, sorting of fish, repairing of engines were among the other economic activities of the indirect fishery workers. The IFWs should be registered under the Department of Fisheries and Aquatic Resources to upgrade their services. This may lead to increase the quality of services provided by them and to upgrade their socio-economic status.

Keywords: indirect fishery worker, semi-structured questionnaire, socio-economic aspects

*Corresponding author – email :wimalherathykk@gmail.com

Socio-economic determinants of the fish purchasing decision and consumption behavior in Gampaha District, Sri Lanka

K.P.G.L. Sandaruwan, D.W.L.U. De Silva, G.D.T.M. Jayasinghe and B.K.K.K. Jinadasa

National Aquatic Resources Research and Development Agency (NARA), Crow Island, Colombo 15, Sri Lanka

The end-user of fish marketing system determines the success of the system by their purchasing and consumption behaviour. This study is aimed to identify the determinants of the fish purchasing and consumption behaviours of residents in Gampaha District, Sri Lanka. Total of 201 respondents were selected from stratified random sampling. The data were collected through face to face interview by using a pre-tested semi-structured questionnaire from June to November 2016. The age, religion and the level of the education are not shown a significant impact on the quantity of fish consumed. The geographical distance to fish market is a critical determinant for price and quantity of fresh fish consumed. There is an association between fish varieties and income groups. The high income group purchased significantly higher amount of expensive fish varieties than that of other income groups. Mobile vendors and fish stalls were the prominent sources of fish purchase. Majority of consumers (71%) pointed out that there is a need of improving quality and hygienic condition of fish at the retailer level. This study revealed that 59% of consumers have not sufficient knowledge to identify fish varieties either in fresh or dried form. Hence, it is recommended to conduct awareness programmes to improve the knowledge of consumers to identify fish varieties in fresh or dried form and its status of quality.

Keywords: consumption determinants, fish consumption, Gampaha District

**Corresponding author – email : lihirusandaruwan@gmail.com*