

NARA SCIENTIFIC SESSIONS - 2025

PROCEEDINGS

— “BRIDGING RESEARCH AND POLICY FOR BLUE GROWTH”



**NATIONAL AQUATIC RESOURCES RESEARCH AND
DEVELOPMENT AGENCY(NARA)**

"A thriving assemblage of *Acropora cf. muricata* rises like underwater thickets, accompanied by delicate colonies of *Pocillopora damicornis*, capturing the resilience and quiet radiance of Sri Lanka's shallow reefs. A small pod of *Chaetodon trifasciatus* hovers nearby, dutifully grazing and keeping the corals in check. This photograph was taken at approximately 5 m depth in Dutch Bay, Trincomalee, using an Olympus TG-6 compact camera."

(Front page image courtesy: M. P. Hendawitharana)



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Message from the Chairman, NARA



It is with great pleasure that I present the *Proceedings of the NARA Scientific Sessions 2025*. This annual event continues to serve as a vital platform for sharing scientific knowledge and strengthening the contribution of aquatic research to national development. The diversity and quality of the abstracts included in this volume reflect the dedication of our scientists, students, and collaborators to advancing fisheries and aquatic resources research in Sri Lanka.

I wish to express my sincere appreciation to the Organising Committee, the Editorial Team, and all staff members who worked tirelessly to ensure the success of this year's sessions. I also extend my gratitude to all authors and reviewers for their valuable contributions and commitment to maintaining scientific excellence.

I trust that these proceedings will serve as a useful reference for researchers, practitioners, and policymakers, and will continue to inspire innovation and collaboration within the aquatic research community.

Prof. Sanath Hettiarachchi

Chairman

National Aquatic Resources Research and Development Agency (NARA)

Message from the Deputy Director General- R&D, NARA



Sustainable fisheries solutions are key to the blue growth in the face of climate change scenarios. As the marine resources undergo a significant transformation, the sustainability of fisheries, a fundamental component of the blue resources and economy, is at continued risk and needs careful watch. In this endeavour, scientists should focus on innovative solutions and approaches in fisheries resource management to drive blue economy benefits while safeguarding the resource base and environment. The sustainable fisheries and management solutions are bringing together a balance of resource extraction for the benefits of direct and indirect users, as well as economic development of the country through special attention on blue economy perspectives.

In this end, it is great pleasure to me extending my heartiest gratitude to NARA scientific sessions 2025 on **“Bridging Research and Policy for Blue Growth”** in making an avenue for the researchers and academicians to express and share their new ideas and innovative research findings in the fields of fisheries and aquatic resources not only in Sri Lanka but also in other regions of the globe.

I highly appreciate the hard work done by the organising committee and inside as well as outside reviewers for the success of this event held in the National Aquatic Resources Research and Development Agency (NARA) premises in Sri Lanka.

May these scientific sessions be a fruitful and inspiring experience for scientific excellence in fisheries and marine resources.

Dr. Lalith Amaralal Kariyawasam
Deputy Director General – Research & Development
National Aquatic Resources Research and Development Agency (NARA)

Message from the Chairperson, NARA Scientific Committee 2025



It is with great pleasure that I present the *Proceedings of the NARA Scientific Sessions 2025*, held under the theme “**Bridging Research and Policy for Blue Growth.**” This annual event provides an essential platform for scientists, academics, students, and policymakers to exchange knowledge and engage in meaningful dialogue on the future of Sri Lanka’s aquatic resources sector. This year, we received 76 abstracts from national research institutions and academia, along with one international paper, reflecting the growing regional and global interest in Sri Lanka’s aquatic research initiatives.

The chosen theme underscores the critical need to strengthen the link between scientific evidence and policy development to support sustainable blue growth. As the national institution mandated to lead aquatic research, NARA plays a pivotal role in generating the scientific foundation required to guide policy decisions, resource management strategies, and sectoral development.

By aligning research outputs with national priorities, NARA directly contributes to sustainable fisheries management, ecosystem conservation, climate resilience, and blue economic advancement.

I also take this opportunity to congratulate all the authors for their research achievements, which demonstrate scientific rigour, innovation, and meaningful contributions to the country’s aquatic resources sector. Through the dissemination of research findings, whether through scientific sessions, publications, stakeholder engagements, or policy dialogues, NARA ensures that new knowledge is effectively translated into practical outcomes that support national development.

These proceedings represent another important step in strengthening evidence-based decision-making and supporting Sri Lanka’s journey toward resilient and inclusive blue growth.

Dr. Sujeewa Athukoorala
Senior Scientist
Marine Biological Resources Division
National Aquatic Resources Research and Development Agency (NARA)

Message from Co-sponsor: Director, CSL-CER



It is my great pleasure to extend the warmest congratulations on the convening of the NARA Scientific Sessions 2025. This annual event has become a fantastic platform for Sri Lanka's marine science community and its international partners to exchange ideas, present new findings, and explore emerging challenges in ocean and climate research.

Over the past decade, the partnership between the CSL-CER (China - Sri Lanka Joint Centre for Education and Research) and NARA has grown steadily and productively. Together, we have advanced long-term ocean observations in the eastern Indian Ocean, developed numerical forecasting tools for tropical cyclones and extreme rainfall, and shared cruise data, samples, and expertise. Through the ANSO and UCAS scholarship programmes, we have also supported the training of a new generation of Sri Lankan marine scientists-an investment that will continue to strengthen our collaboration well into the future.

Looking ahead, we are committed to further deepening our cooperation through joint research projects, expanded observational networks, academic exchanges, and co-organised scientific workshops. By working together, we can contribute more effectively to understanding the Indian Ocean system and to enhancing regional resilience under a changing climate.

I wish the NARA Scientific Sessions 2025 great success and look forward to the new opportunities for future collaborations that this gathering will inspire.

Prof. Changsheng Zhang
Director,
China - Sri Lanka Joint Centre for Education and Research
Deputy Director-General,
South China Sea Institute of Oceanology, Chinese Academy of Sciences

Cover Page Design

Ramodh Jayawardena

Contact:

Telephone: 011-2521000/011 2521006

Fax: 011-2521932

Email: postmaster@nara.ac.lk

Web: www.nara.ac.lk

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Fisheries

Assessment of target and incidental catch in artisanal shrimp trawl fishery operated by traditional dugout canoes in Poruthota, on the west coast of Sri Lanka

H. D. S. Hathurusinghe^{1,2*}, W. K. P. Fernando³, W. S. Thilakaratna², P. B. M. Pathirana², and N. P. Pushpitha¹

¹*Department of Fisheries and Marine Science, Faculty of Fisheries and Ocean Sciences, Ocean University of Sri Lanka, Mahawela Road, Tangalle, 82200, Sri Lanka.*

²*Ocean Rosy Organisation, Colombo 00600, Sri Lanka.*

³*Sri Lanka Institute of Information Technology, Malambe, 10115, Sri Lanka.*

The artisanal shrimp trawl fishery at the Poruthota traditional catamaran harbour on Sri Lanka's west coast employs 12-m-long dugout canoes fitted with sail-driven small-mesh trawl nets, ranging from 1.5 to 1 cm toward the cod-end. This study aimed to identify target, edible bycatch, and discarded species, estimate CPUE, and fishers' income during the early, middle and end phases of the second inter-monsoon period. Data was collected from 42 fishing trips involving randomly selected canoes from October to December 2024. This fishery mainly targeted five shrimp species. *Metapenaeus dobsoni* and *Parapenaeopsis coromandelica* accounted for the highest percentage, each with 29%, followed by *Penaeus indicus* and *Penaeus merguensis*, which contributed 17% each. *Penaeus monodon* accounted for the smaller share at 8%. Non-target catch included 27 commercially valuable bycatch species and 13 discarded species. Bycatch was primarily composed of *Cynoglossus bilineatus*, *Opisthopterus tardoore*, *Otolithes cuvieri*, and *Portunus pelagicus*, while discarded species mainly included *Arius jella*, *Clorida latreillei*, and *Turritella communis*. Results revealed a significant difference in catch rates among phases (One-way ANOVA; $p = 0.029$, $F = 6.29$). Games–Howell post hoc test showed that the early phase (24.16 ± 15.50 kg/h) had significantly higher target CPUE than the middle (6.36 ± 11.83 kg/h) and end phases (1.46 ± 0.75 kg/h). The mean edible bycatch CPUE of the middle (3.82 ± 3.51 kg/h) was significantly higher than the early (2.347 ± 1.423 kg/h) and end phases (2.324 ± 1.794 kg/h). The mean discarded CPUE of the middle phase (3.98 ± 3.961 kg/h) was significantly higher than the early (3.352 ± 2.294 kg/h) and end phases (2.414 ± 1.062 kg/h) but did not differ significantly among phases ($p=0.653$, $F=0.45$ and $p=0.533$, $F=0.68$ respectively). Total income (LKR 483,250) was highest during the early phase and declined toward the end phase (LKR 23,400). Consequently, fishers shifted towards Pesca tourism. This study recommends further research across different monsoon periods.

Keywords: Bycatch, CPUE, Monsoon, Sailboat, Traditional fishery

*Corresponding author email: dakshinasarangi99@gmail.com

Some reproductive biological aspects of spotted sardinella (*Amblygaster sirm* Walbaum, 1792)) from the East coast of Sri Lanka

K. R. Dalpathadu^{1*}, L.D. Gayathry¹, M.M.C. Karunarathna², U.P.W. Hettiarachchi¹, and S. S K. Haputhantri¹

¹*Marine Biological Resources Division, National Aquatic Resources Research & Development Agency (NARA), Crow Island, Colombo 15, Sri Lanka*

²*IUCN Sri Lanka, 713, D.P. Wijesinghe Mawatha, Pelawatta, Battaramulla, Sri Lanka*

Sri Lanka's marine fisheries heavily depend on coastal resources, accounting for over half of the catch. Coastal fisheries include 122 pelagic and 53 demersal species; *Amblygaster sirm* accounts for 22% of small pelagic catches. Since 2016, small pelagic landings have declined, with limited recent biological data on *A. sirm* stocks on the east coast. This study aimed to investigate the reproductive biology of *A. sirm* in the eastern coastal waters to support future stock assessments and management strategies. Monthly fishery-dependent surveys were conducted from January to December 2018 at key landing sites in the Kalmunai (n = 5) and Batticaloa (n = 2) fisheries districts. A total of 1,535 individuals (626 from Ampara; 909 from Batticaloa) from the gill nets were sampled, and the total length, weight, and gonad characteristics were recorded. Gonadal maturity was classified macroscopically, sex ratios were determined, and reproductive parameters such as the size at 50% maturity (L_{50}) and spawning season were estimated. Specimens ranged from 13.0 to 22.7 cm in total length, with a mean of 16.8 cm. The observed sex ratio of males: females was 1:1.33, which was significantly biased toward females ($\chi^2 = 31.32$, $p < 0.0001$), consistent with previous studies in Sri Lanka but contrasting with male-biased ratios reported from India. Temporal variation in sex ratios indicated male dominance before spawning and female dominance after spawning. L_{50} was estimated at 16.1 cm for males, 17.9 cm for females, and 17.0 cm for combined sexes, highlighting the larger maturation size of females. Gonadosomatic index analysis revealed a distinct peak in July, with the season extending into August. These findings demonstrate spatial variation, emphasising the need for region-specific management, such as size limits and protection of the spawning season, for sustainability.

Keywords: sex ratio, spawning season, size at 50% maturity, fishery management, Sri Lanka east coast

*Corresponding author: kasun.randikad@gmail.com

Current status of the lobster fishery in the Southern Coast of Sri Lanka

J.K.D.U. Jayasekara*, J.M.S.N. Rathnapala, and W.S. Weerakkody

Department of Fisheries and Aquaculture, Faculty of Fisheries and Marine Sciences & Technology, University of Ruhuna,

The lobster fishery along the southern coast is one of the most commercially significant industries, serving both local and international markets. The present study was designed to evaluate the status of the lobster fishery in the Southern coastal region, aiming to assess resource utilisation patterns, identify key challenges and management gaps, and provide insights for the sustainable development of the industry. A total of 168 lobsters were sampled from 14 sites, including major and minor landing sites, and collection centres in the Tangalle, Matara, and Galle areas during July–September 2024. Primary data on species catch composition, lobster selling prices, lobster fishermen data, types of fishing gear, vessel types used by the fishermen, and socioeconomic status of fishermen were collected through semi-structured interviews, field observations, and focus group discussions. Five *Panulirus* species were recorded: *Panulirus homarus*, *P. versicolor*, *P. ornatus*, *P. penicillatus*, and *P. longipes*. *P. homarus* was dominant (73.81%), while *P. longipes* was the least abundant (1.19%). Tangalle contributed the highest proportion of catch (71.43%). The logarithmic transformation of the carapace length/total weight relationship revealed growth coefficients (b) ranging from 1.84 to 2.75, indicating negative allometric growth ($b < 3$) of all species. Tangalle contributed the highest catch (71.43%), followed by Matara (18.45%) and Galle (10.12%). According to species composition, Galle showed higher proportions of *P. versicolor* (29.41%) and *P. ornatus* (23.53%), while Tangalle was dominated by *P. Homarus* (85.0%). Most of the gear used was bottom-set gill nets (92%), and 56.85% operated outboard fibre-reinforced plastic craft, while 43.15% relied on traditional non-mechanised craft. Socioeconomic data revealed that the lobster fishery is predominantly male (99%), with most respondents (58.22%) having 20–50 years of fishing experience; only 2.05% had more than 50 years, while 39.73% had less than 20 years. Experienced fishermen within this age group typically selected a ‘Maha Marakkalei’ as their leader. The SWOT analysis revealed that despite the high profitability, the lobster fishing industry poses a threat to the lobster population due to over-exploitation, inadequate compliance with regulatory frameworks, and insufficient awareness. The current study indicates that the lobster fishery is economically valuable but jeopardises the wild lobster population due to inadequate stakeholder oversight along the Southern coast region.

Keywords: Spiny lobster, *Panulirus sp.*, Southern Coast, Length-Weight relationship, Lobster Fishery

*Corresponding author email: muthujayasekara97@gmail.com

From signals of underfishing to overfishing and plastic pollution - on the Nansen surveys off Sri Lanka 1978 – 2018

Jens Otto Krakstad¹, Prabath Jayasinghe², and Ole Arve Misund^{1*}

¹*Institute of Marine Research, P.O.Box 1870, N-5024 Nordnes, Bergen, Norway*

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

The Norwegian Research Vessel “Dr Fridtjof Nansen”, operating under the United Nations flag, conducted four surveys in the waters of Sri Lanka in the forty-year period from 1978 to 2018. During the first three surveys carried out annually in 1978 - 1980, a total fish abundance of 520,000, 400 000 and 385,000 tons, respectively, was measured by fisheries acoustics. In the 2018 survey, conducted on the larger and better-equipped third “Nansen” vessel, the total fish abundance recorded was just 173,000 tons, less than half of what was recorded 40 years earlier. The fisheries acoustic recordings in the 2018 survey amounted to 121,000 tons only. An additional 52,000 tons were estimated using the bottom trawl and the swept area method. These numbers indicated a substantial reduction in the standing biomass of fish species off Sri Lanka. Plastic waste and remains of fishing gear were caught in a large proportion in the 2018 bottom trawls, but such items were not reported 40 years earlier. From the first two surveys, signals of potential increases in catches by a factor of two and the use of longlining for catching deepwater rockfishes were observed. The substantial reduction in standing fish biomass 40 years later indicated a need for fisheries management plans with effective management measures to make Sri Lankan fisheries sustainable. Recent population dynamic analysis of several coastal species indicates that overfishing calls for action, also. Such measures can include a reduction in fishing effort, possibly closed areas and seasons, and technical regulations as more selective fishing.

Keywords: fisheries acoustic surveys, swept area estimate, fish abundance, overfishing, fisheries management plans

*Corresponding author email: ole.arve.misund@hi.no

Application of data-limited length-based assessment tools to the longspine grouper (*Epinephelus longispinis*, Kner, 1864) fishery in Sri Lanka

A.A.S.H. Athukoorala*, D.G.T.C. Balawardana, J. Wicramaarachchi, and R.P.P.K. Jayasinghe
National Aquatic Resources Research and Development Agency (NARA), Crow Island, Colombo 15, Sri Lanka

The longspine grouper *Epinephelus longispinis* (Kner, 1864) is a reef-associated species widely distributed in the Indian and Pacific Oceans and valued as a food fish. However, stock assessment efforts are limited for this species in Sri Lankan waters to date. This study aimed to assess the stock status of *E. longispinis* using length-based stock assessment methods developed for data-limited fisheries. Total length data of 176 longspine groupers were collected from the Negombo and Beruwela area on the west coast of Sri Lanka between March 2024 and August 2025, covering two monsoon periods. Analyses were performed by using the open-source software “TropFishR” for Electronic Length Frequency Analysis (ELEFAN) to estimate von Bertalanffy Growth Function (VBGF) parameters, along with Length-Based Indicators (LBI) (L_c , $L_{25\%}$, L_{max} , L_{mean} , $L_{95\%}$, $L_{max5\%}$) and the Length-Based Spawning Potential Ratio (LBSPR), which provide key information for managing data-poor fisheries. The estimated VBGF parameters were: asymptotic length $L_\infty = 62$ cm, growth coefficient $K = 0.131 \text{ year}^{-1}$, natural mortality $M = 0.238 \text{ year}^{-1}$, and fishing mortality $F = 0.434 \text{ year}^{-1}$. LBIs relative to reference levels indicated both growth and recruitment overfishing during the study period, suggesting the fishery is not operating at a sustainable level, although in 2024, it was close to the maximum sustainable yield (MSY). The spawning potential ratio (SPR), estimated using LBSPR, was far below the recommended reference value of 40%, at 0.39% in 2024 and 0.12% in 2025. These findings demonstrate that the *E. longispinis* stock on the west coast of Sri Lanka is being fished at levels far exceeding sustainability and highlight the urgent need for immediate management interventions to prevent further depletion of this resource.

Keywords: Data-limited; ELEFAN; LBI; LBSPR; Length-based

*Corresponding author email: athukoorala@nara.ac.lk

Challenges in sustainable management of shark by-catch in Sri Lanka: biological and fishery perspectives from the Western and Southern Coasts

D. G. T. C. Balawardhana*, A. A. S. H. Athukoorala, R. P. P. K. Jayasinghe, and S.S.K. Haputhantri

Marine Biological Resources Division, National Aquatic Resources Research and Development Agency (NARA), Colombo 15

Shark bycatch landings in Sri Lanka have recently become a growing concern in the Indian Ocean region, as different sources highlight the unsustainable landings around the country. Thus, Sri Lanka has implemented relevant management measures to ensure a sustainable fishery. This study focused on identifying the significant challenges that have made it difficult to manage bycatch landing at a sustainable level. Monthly data collection was conducted at the Negombo, Beruwala, Mirissa, and Tangalle Fisheries harbours from January 2024 to August 2025 to gather information on fishing operations, as well as biological and landing data on sharks. A total of 173 individuals of sharks were recorded, representing 13 species identified to the species level. Among those, the Silky shark (*Carcharhinus falciformis*) was recognised as the dominant species (48.5%), followed by the Blue shark (*Prionace glauca*) (26.4%) and Shortfin Mako (*Isurus oxyrinchus*) (18.1%). Catch per unit effort (CPUE) was estimated at 0.023 individuals/1000 hooks for silky sharks and 0.014 individuals per 1,000 hooks for blue sharks. The length-frequency distribution of dominant shark species shows that landings were mostly composed of immature silky sharks (100-190cm TL), mature blue sharks (295-342 cm TL), and tiger sharks ranging from 245-398 cm TL. Five pregnant female sharks were also recorded during the survey. The questionnaire survey revealed the use of shark longline as supplementary gear, indicating a shift towards targeting sharks, driven by the high market value of shark fins. The comparison between observed shark landings and logbook records highlighted underreporting, which may lead to misleading conclusions on shark bycatch in Sri Lanka. These findings highlight the sustainable management of shark landings in Sri Lanka, which requires greater attention from the relevant authorities.

Keywords: By-catch, Challenges, Management, Shark, Sri Lanka

*Corresponding author email: thejani.mbrd@nara.ac.lk

Gut content analysis of Kawakawa (*Euthynnus affinis*) from the Negombo Landing Site, Sri Lanka

M.H.F. Ilma¹, J. Wicramarachchi², Indu Kumara², J. A. C. Prasad², R. P. P. K. Jayasinghe², K.K.T. Nuwansi¹, W.A.A.D.L. Wickramasinghe¹, and A.A.S.H. Athukoorala^{2*}

¹*Department of Aquaculture and Seafood Technology, Faculty of Fisheries and Ocean Sciences, Ocean University of Sri Lanka, Crow Island, Colombo 15, Sri Lanka*

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

Kawakawa (*Euthynnus affinis*), a small pelagic tuna widely distributed across the Indo-Pacific Oceans, is an ecologically and commercially important species in Sri Lanka. This study examined the gut content of Kawakawa (*Euthynnus affinis*) to better understand its trophic interactions and ecological role via gut content analysis. A total of 50 specimens (31 females, 19 males), (length 21.5–66.5cm) were collected from the Negombo fish landing site from March to August 2025. Standard morphometric measurements were recorded, and gut contents were quantified using the gravimetric method. Among the examined specimens, 24% of guts (21.5–46.5 cm TL) were empty, as, 32.26% of females and 10.53% of males. This Empty Stomach Ratio (ESR) of 24% indicates a moderate proportion of non-feeding individuals, likely associated with post-capture digestion and spawning-related activity. The Index of Relative Importance (IRI) revealed fish as the dominant prey (IRI = 2256), whereas shrimp (IRI = 47.56), squid (IRI = 38), and unidentified items (IRI = 5) played only a minor role in the diet. Stomach Fullness Index (SFI), expressed parts per thousand, indicated that smaller individuals (20–24 cm) showed low feeding activity (FA = 10%; SFI = 0–9‰), while larger fish (>40 cm) exhibited consistently higher values (SFI up to 779.48‰) with 100% feeding activity. Notably, females dominated the sample, possibly due to nearshore spawning migrations. The calculated trophic level of *Euthynnus affinis* was 4.5, confirming its role as a top-level predator primarily feeding on carnivorous prey. These findings provide valuable baseline data on the feeding ecology and trophic level interaction of *Euthynnus affinis*. To better understand seasonal variation, including potential differences between monsoon and non-monsoon periods, future studies should extend the sampling period to cover a full annual cycle. This baseline data can be used for kawakawa fishery management.

Keywords: Kawakawa, Gut content analysis, Index of Relative Importance, Stomach Fullness Index, Trophic level, Empty Stomach Ratio

*Corresponding author: athukoorala@nara.ac.lk

Aquaculture

Use of biofloc system to increase growth, survival, and immunity of guppy *Poecilia reticulata* (Petres 1859)

W.B.W.M.K.R. Aluvihare¹, A.M.A.N. Adikari^{2*}, K.K.A. Sanjeewa², K.L.W.T Maduka², and P.P.M. Heenatigala²

¹Department of Biosystems Technology, Faculty of Technology, University of Sri Jayewardenepura, Sri Lanka

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

The culture of guppy fish (*Poecilia reticulata*) as an ornamental fish species represents a rapidly expanding aquaculture sector with significant economic potential. Enhancing production per unit area while minimising environmental degradation is essential for maximising the sustainability and overall benefits of the guppy aquaculture industry. This study evaluated the application of Biofloc Technology (BFT) as a sustainable nursery system for guppy culture. Five treatments with three replicates were tested using different carbon sources: molasses (T1), rice bran (T2), wheat flour (T3), molasses and rice bran (T4), molasses and wheat flour (T5), and a control group without BFT (C). One-month-old Guppy (0.10 ± 0.01 g) were stocked at a density of one fish per litre in tanks with an effective volume of 80 L. The biofloc treatment was maintained without water exchange, whereas the control tanks underwent water exchange every 3 days. Growth and survival were monitored weekly for six weeks, and water quality parameters (temperature, DO, pH) were measured every other day. Total ammonia nitrogen (TAN) and nitrate, nitrite, and TDS levels were recorded weekly. Additionally, a challenge test against *A. hydrophila* was conducted to evaluate the immune response of fish reared under each treatment. Among the treatments, T4 demonstrated significantly superior performance ($p < 0.05$), with the highest weight gain ($254.52 \pm 20.03\%$), specific growth rate ($2.81 \pm 0.07\%/day$), survival rate ($93.33 \pm 2.08\%$), and disease resistance in the challenge test ($96.67 \pm 4.71\%$ survival). Water quality in T4 remained within optimal ranges throughout the study, with pH at 7.12 ± 0.03 , DO at 7.11 ± 0.21 mg/L, and temperature at $28.35 \pm 0.73^\circ\text{C}$. Nitrogenous waste levels in T4 indicated efficient assimilation, with TAN at 0.59 ± 0.15 mg/L, nitrate at 5.76 ± 0.33 mg/L, and nitrite at 0.38 ± 0.17 mg/L. These findings highlight the efficacy of Biofloc Technology, particularly when combined with molasses and rice bran (T4), in enhancing the growth, survival, and immune response of guppy fry while maintaining optimal water quality.

Keywords: Carbon sources, biofloc system, *Poecilia reticulata*, water quality

*Corresponding author email: adikariaman@gmail.com

Biofloc as an outdoor nursery system for sandfish (*Holothuria scabra*) aquaculture

T. I. Kumarasiri^{1*}, A.M.A.N. Adikari², P.P.M Heenatigala², K.L.W.T Maduka², S.B.K. Subasinghe², and D.C.T. Dissanayake¹

¹Department of Zoology, University of Sri Jayewardenepura, Gangodawila, Nugegoda, Sri Lanka

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

Sandfish (*Holothuria scabra*) aquaculture in Sri Lanka holds promising economic benefits but faces major challenges due to inadequate infrastructure and limited technical expertise in nursery rearing. The absence of standardised nursery systems necessitates an intermediate step, as hatchery-produced juveniles (1-2 g) are too small for viable direct stocking into lagoon or sea pens. Therefore, this study evaluates Biofloc Technology (BFT) as a sustainable outdoor nursery system by comparing three treatments: biofloc-only (T1), biofloc with marine sediment (T2), and sediment-only (T3). The experiment was conducted at NARA from February to May 2025 with a trial period of six weeks. Sandfish juveniles (1-2 g) were stocked at a density of 10 individuals/m² in three replicate tanks, each with a capacity of 1000 L, for every treatment. Biofloc treatments (T1 and T2) were maintained without water exchange, whereas T3 received weekly water exchange with UV-filtered seawater. Growth performance and survival were monitored weekly, while water quality parameters, including temperature, dissolved oxygen, salinity, and pH, were measured daily. Total Ammonia Nitrogen (TAN) and nitrite were measured weekly, and microbial communities were assessed in all treatments. Results showed that T2 significantly outperformed T1 and T3, with a weight gain of 68.34%, length gain of 47.46%, and specific growth rate of 2.74%/day ($p < 0.05$; ANOVA). In comparison, T3 recorded a weight gain of 19.76 %, length gain of 34.07 %, and specific growth rate of 0.99 %/day. Survival was 100% across all treatments. T2 also maintained stable water quality (pH 7.8–8.0, DO 8.1-8.5 mg/L, and temperature ~29.3 °C. TAN (0.1-0.2 mg/L) and nitrite (0.1 ppm), indicating efficient nutrient cycling. Microbial analysis showed that T2 recorded the highest colony-forming units. The microbial communities in both T1 and T2 were highly abundant with *Bacillus* spp., whereas *Vibrio* spp. was the predominant in T3. These findings highlight the potential of the biofloc-sediment system (T2) as a resource-efficient outdoor nursery approach that reduces reliance on external feed and operates under a zero-water-exchange setup. By enhancing growth and maintaining water quality, this approach offers a promising solution for adoption in resource-limited hatcheries.

Keywords: Sandfish, outdoor nursery, biofloc, hatchery-reared juveniles

*Corresponding author email: adikari.aman@gmail.com

Optimal stocking density and microbial dynamics in recirculating aquaculture systems for *Poecilia reticulata*

N.P. Dehiwatta¹, A.M.A.N. Adikari^{2*}, P.P.M. Heenatigala², K.L.W.T Maduka², and S.B.K. Subasinghe²

¹*Department of Environmental Technology, Faculty of Technology, University of Colombo, Sri Lanka*

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

The research aims to provide a sustainable solution for the increasing demand in the ornamental fish industry by identifying appropriate stocking densities for guppy (*Poecilia reticulata*) cultured in a recirculating aquaculture system (RAS). Five different stocking densities, 1, 2, 3, 4, and 5 fish per litre, were tested, with monitoring of water quality parameters of pH, temperature, ammonia, nitrite, and nitrate. Growth performance parameters, including weight gain, survival rate, and feed conversion ratio (FCR), Specific Growth Rate (SGR), were assessed. The results show that lower stocking densities resulted in superior growth. Specifically, the density of 1 fish per litre yielded the highest SGR at 0.21% per day and a survival rate of 93.75%. The density of 2 fish per litre achieved the lowest FCR (1.87 ± 0.24), indicating optimal feed efficiency. At higher densities, water quality and growth rates declined, with the highest ammonium concentration observed at 0.46 mg/L in the 3 fish/L treatment, while 1 fish/L, 4 fish/L, and 5 fish/L recorded 0.35 ± 0.19 mg/L, 0.35 ± 0.19 mg/L, and 0.40 ± 0.28 mg/L, respectively. pH level was stabilising between 8.34 and 8.48 across densities. All treatments showed survival rates above 80%, indicating that 1- 5 fish/L stocking densities can be successfully cultured in a recirculating aquaculture system with a 2X per hour turnover rate. 16S rDNA sequencing showed 19 bacterial isolates grouped into three clades: *Lysinibacillus* and *Bacillus* spp. in mechanical filters involved in organic degradation; *Bacillus*, *Enterobacter*, and *Acinetobacter* spp. in biofilters supporting nitrogen cycling; and *Streptomyces* and *Planococcaceae* in UV filters aiding waste conversion. The presence of these microbial communities indicates that the RAS system was functioning at full efficiency. In the present study, a stocking density of 1 fish per litre yielded the best growth. However, based on overall water quality and FCR, the stocking density of 2 fish per litre was optimal for cultivation in the RAS. Further research is suggested to balance density with economic viability by conducting a cost-benefit analysis and providing a clear understanding of sustainable guppy fish (*Poecilia reticulata*) culture in RAS rather than conventional methods, potentially benefiting Sri Lanka's ornamental fish market.

Keywords: Economic viability, growth efficiency, ornamental fish, recirculating aquaculture systems, stocking density.

*Corresponding author email: adikariaman@gmail.com

Prevalence and Characterization of *Enterocytozoon hepatopenaei* (EHP) and Its Potential Host Range in Shrimp Aquaculture along the Northwestern Coast of Sri Lanka

P.P.M. Heenatigala^{1*}, A. M. A. N. Adikari¹, A. H. T. Perera¹, L. T. D. Lokuvithana³, S. B. K. Dunusinghe¹, G. Hemali Rupika¹, K. S. L. S. Hesara², Y.N.R. Nilupa Kumari²

¹*Inland Aquatic Resources and Aquaculture Division, National Aquatic Resources Research and Development Agency (NARA), Crow Island, Colombo 15, Sri Lanka*

²*Hydrographic Division, National Aquatic Resources Research and Development Agency, Sri Lanka*

³*Department of Biological Sciences, Rajarata University of Sri Lanka.*

Enterocytozoon hepatopenaei (EHP) is a microsporidian parasite affecting the hepatopancreas of cultured shrimp, leading to growth retardation and major economic losses. Prevention and management remain the best solution for EHP outbreaks. Thus, an in-depth study was conducted in Northwestern Province (NWP) to identify the suitable control measures on EHP disease prevalence of shrimps. 135 shrimp, 135 water samples, and 70 macrofauna were collected from 109 randomly selected shrimp culture sites covering all five shrimp farming zones. GPS coordinates of sampling locations were recorded for the disease prevalence mapping. EHP infected animals were detected using nested PCR targeting the spore wall protein (SWP) gene and the amplified PCR product were sequenced. Phylogenetic analysis was conducted by MEGA 12 to determine the genetic lineage of the parasite. Physico-chemical parameters and *Vibrio* counts were monitored in the water samples as *Vibrio* species are responsible for several devastating diseases in shrimp. *Vibrio* species identification was achieved by 16s rRNA sequencing. EHP prevalence in shrimp was 57.03%, with the 66.66% highest incidence in Mundalama. Disease prevalence mapping identified the Chilaw, Puttalam Lagoon, and Mundalama Lagoon areas as EHP hotspots in NWP. Among macrofauna tested, 92.85% were positive for EHP, with crabs (95%) and gastropods (93.33%) showing the highest EHP prevalence, indicating the role of macrofauna as EHP carriers. EHP was found to tolerate a wide range of water quality parameters (Salinity 2–30 ppt, pH 7–8, DO 3–12 mg/L, Ammonia 0.6–1.3 mg/L, Phosphorus 0.1–0.46 mg/L). *Vibrio parahaemolyticus* was the dominant *Vibrio* spp. identified in infected animals and ponds. Phylogenetic analysis revealed four EHP strains, clustered closely with Thai/Indian strains and one clustering with Malaysian/Indian strains, indicating possible indirect introduction via shared broodstock sources as Sri Lanka does not import shrimp brood-stock from Malaysia and India. The study highlights the high prevalence and adaptability of EHP, the role of macrofauna as potential reservoirs, and the importance of strict biosecurity measures and molecular surveillance.

Keywords: Shrimp culture, EHP, Disease, Water quality, Macrofauna

*Corresponding author email: prajani15@hotmail.com

Effects of Southwest monsoonal freshwater inflow on the growth and survival of the clam *Meretrix casta* in Rekawa Lagoon

K.W.G. Chalaksha¹ and K.W.R.R. Amaraweera^{2*}

¹Faculty of Animal Science & Export Agriculture, Uva Wellassa University, Badulla, Sri Lanka

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

Effects of southwest monsoonal freshwater inflow on the growth, survival, and habitat suitability of *Meretrix casta* were assessed in Rekawa Lagoon, Sri Lanka. Four sites with different hydrological and sediment conditions were studied to observe how clams respond along a freshwater impact gradient. Wet flesh weight and percentage edibility were measured monthly for sexually mature clams (50 individuals, shell length 25-26 mm) at each site from March to August 2025. Gonad development was examined microscopically, and population density was determined using a square metre quadrat. Water quality parameters, including salinity, dissolved oxygen, pH, conductivity, temperature, water depth, and secchi depth transparency, were monitored fortnightly. Bottom sediments were analysed for texture, and salinity tolerance was experimentally tested (0–20 ppt). During the peak of the monsoon (May-June), salinity, conductivity, dissolved oxygen, and Secchi depth transparency decreased, while water depth in the lagoon increased. These changes corresponded to significantly low growth in wet flesh weight (0.94 g), a reduced edibility percentage (0.21%), and a low population density (3-5 individuals/m²). Sandy substrates near the lagoon mouth & Modara Ala (Sites A and B) support resilient habitats where clams can thrive. Silt and mud substrates with salinity below 5 ppt (Godigamuwa & Hettiyapokuna, Sites C and D) became uninhabitable, resulting in complete clam loss during the monsoon. Salinity tests in the laboratory confirmed limited physiological tolerance, with a 25% survival rate below 5 ppt after one month. The population density was highest in March (40-52 individuals/m²), with a significant presence of ripe gonads in April and May (>60%), indicating a clear pre-monsoon spawning peak. The settled spats were seen in August. Estimation of habitat quality depends on the hydrology-substrate interaction, where sandy habitats with salinity levels above 5 ppt provide refuges from monsoon stress. Results indicate that South-West monsoonal freshwater inflow significantly restricts the distribution, growth, and reproductive biology of *Meretrix casta*. These findings are important for understanding monsoon-driven bivalve processes and have key implications for sustainable lagoon clam-fishery management amid increasing climatic and hydrological uncertainties.

Keywords: *Meretrix casta*, Rekawa Lagoon, Monsoon, Growth, Salinity, Sediments

*Corresponding author email: ruchiraamaraweera2@gmail.com

Development of an effective surface sterilisation protocol for *In Vitro* micropropagation of *Cryptocoryne beckettii* rhizomes

W. P. P. S. V. Sovis^{1*}, D.M.S. Sugeeshwari², R. Wimalasekera¹, G. D. Sinniah¹, and W.A.K.D. Madurangika²

¹Department of Botany, University of Sri Jayewardenepura, Sri Lanka

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

Cryptocoryne beckettii (Beckett's water trumpet) is a highly valued aquatic plant in the aquarium trade, particularly in Sri Lanka. It is endemic to the island and listed as vulnerable. Microbial contamination makes it difficult to multiply the plant by micropropagation. This study was conducted to develop an effective surface sterilisation protocol for *Cryptocoryne beckettii* rhizome (explants). The study was conducted at the plant tissue culture laboratory at the National Aquatic Resources Research and Development Agency (NARA). In this study, nine different treatments (T1-T9) were used with three varying concentrations of NaOCl and three different exposure times. These treatments included different concentrations of NaOCl, such as 0.25%, 0.40%, and 0.50% and exposure times of 5, 8, and 10 minutes. Treatments without any disinfection served as the control for explant sterilisation. Each treatment was tested in triplicate with five explants per replicate. The survival rate and percentage of microbial contamination were assessed over forty-five days. The results showed that increasing NaOCl concentration and exposure time led to a significant reduction in total microbial contamination, coupled with improved explant survival. Surface sterilisation with 0.50% NaOCl for 10 minutes was the most effective sterilisation protocol, achieving the highest survival rate ($93.33 \pm 0.5\%$) and significantly reducing total contamination ($6.67 \pm 0.6\%$). In contrast, 0.25% NaOCl for 5 minutes resulted in the highest fungal contamination ($93.33 \pm 0.5\%$) and the lowest survival rate ($6.67 \pm 0.6\%$). This result shows the optimal balance between eliminating fungal contamination and preserving tissue viability. This study successfully identified an optimised and reliable sterilisation protocol for the *in vitro* propagation of *Cryptocoryne beckettii* using explants. The findings provide a strong basis for producing healthy, disease-free *C. beckettii* plantlets on a large scale, thereby contributing significantly to the sustainable supply for the aquarium industry and to conservation efforts for this vulnerable species.

Keywords: *Cryptocoryne beckettii*, Micropropagation, Surface Sterilisation, Sodium Hypochlorite, Microbial Contamination

*Corresponding author email: sovispamila@gmail.com

Prevalence and intensity of *Octolasmis* spp. gill parasitism in wild mud crab (*Scylla* spp.) populations along Sri Lankan coastal waters

K.R.P.S. Premarathne¹, R.M.P.A. Bandara¹, A.W. Kalupahana², S.H.N.P. De Silva³, and S.S.S.de.S. Jagoda^{1*}

¹Center for Aquatic Animal Disease Diagnosis and Research, Department of Veterinary Pathobiology, Faculty of Veterinary Medicine and Animal Science, University of Peradeniya, Peradeniya, 20400, Sri Lanka.

²Department of Veterinary Pathobiology, Faculty of Veterinary Medicine and Animal Science, University of Peradeniya, Peradeniya, 20400, Sri Lanka.

³Department of Crop Science, Faculty of Agriculture, University of Peradeniya, Peradeniya, 20400, Sri Lanka.

Gill-parasitic barnacles (*Octolasmis* spp.) represent significant health threats to crustaceans, yet comprehensive prevalence data for tropical mud crab populations remain limited. This study provides baseline prevalence and intensity data for *Octolasmis* spp. parasitism in wild mud crab (*Scylla* spp.) populations along Sri Lankan coastal waters. Sixty mud crabs were collected directly from local fishermen at ten coastal sites (Negombo, Chilaw, Puttalam, Kalpitiya, Mannar, Jaffna, Mullaitivu, Trincomalee, Batticaloa, and Galle) during 2024-2025. Individual crabs were examined for gill-attached *Octolasmis* spp. barnacles, and the number of parasites was recorded. Host morphometrics (weight, carapace length, and width) were measured. Parasite prevalence, mean intensity, and abundance were calculated following standard parasitological protocols. Statistical analyses included Wilson's Score confidence intervals, Spearman's rank correlation, and distribution testing. Overall *Octolasmis* spp. prevalence was 21.67% (13/60 crabs, 95% CI: 12.28-33.98%) with a total of 313 individual barnacles recorded. Mean parasite intensity among infected hosts was 24.08 ± 13.45 barnacles. Parasite abundance was 5.22 ± 12.89 barnacles per crab. High variation in parasite attachment intensity was observed, with 23.1% of infected crabs carrying >30 barnacles. Significant spatial variation was evident: highest prevalence at Mannar and Kalpitiya (50% each), followed by Trincomalee and Batticaloa (33.33% each), while Negombo, Jaffna, and Mullaitivu showed no parasitism. Host crabs averaged 220.45 ± 52.37 g in weight, 112.5 ± 10.8 mm carapace length, and 76.0 ± 8.9 mm carapace width. Spearman's rank correlation analysis revealed no significant relationships between host size and parasite abundance ($r_s = 0.09-0.14$, $p > 0.05$). Sex ratio was balanced (53.3% males, 46.7% females), with males showing slightly higher prevalence (25.0% vs 17.86%, Fisher's exact test, $p = 0.57$). This study establishes that one in five mud crabs from Sri Lankan coasts harbour *Octolasmis* parasites, with loads exceeding 40 barnacles in some individuals. Spatial heterogeneity suggests differential host susceptibility or site-specific environmental exposure intensity. These findings provide baseline data for monitoring the impacts of parasitism on commercially important populations and inform fisheries management strategies.

Keywords: Mud crabs, prevalence, *Octolasmis* spp., gill parasites, *Scylla* spp., Sri Lankan waters

*Corresponding author email: samanthika@vet.pdn.ac.lk

Detection of *Enterocytozoon hepatopenaei* (EHP) in early larval stages of *Litopenaeus vannamei* from hatcheries in Chilaw, Sri Lanka

R.M.P.A. Bandara¹, K. R. P. S. Premarathne¹, E.G.R. Dayananda³, T.A. Gunawardana², N.M.T. Anupama², S.S.S.de.S. Jagoda¹, and A.W. Kalupahana^{2*}

¹*Center for Aquatic Animal Disease Diagnosis and Research, Department of Veterinary Pathobiology, Faculty of Veterinary Medicine and Animal Science, University of Peradeniya, Sri Lanka*

²*Department of Veterinary Pathobiology, Faculty of Veterinary Medicine and Animal Science, University of Peradeniya, Sri Lanka*

³*Coastal Aquaculture Extension and Monitoring unit, National Aquaculture Development Authority, Battuluoya, 61246, Sri Lanka*

Enterocytozoon hepatopenaei (EHP), a microsporidian parasite that causes growth retardation, has emerged as a major pathogen in cultured Pacific white shrimp (*Litopenaeus vannamei*), posing a significant challenge to shrimp aquaculture in Sri Lanka. Early detection is critical, as EHP reduces shrimp growth performance and farm profitability, threatening Sri Lanka's emerging shrimp aquaculture industry. Although the pathogen is often reported in grow-out stages, its occurrence in larval stages remains poorly understood. From June 2024 to July 2025, 100 larval samples were collected from 20 broodstock and nursery hatcheries in Chilaw, including zoea (n=10), mysis (n=15), and post-larvae (PL1–PL15, n=75). Larvae were preserved in 95% ethanol for molecular diagnostics and seawater Davidson's fixative for histopathology. DNA was extracted using the Promega Wizard DNA extraction kit following overnight digestion with proteinase K and screened by conventional nested PCR targeting the spore wall protein (SWP) gene with World Organisation for Animal Health-listed primers. Of 100 larvae screened, 16% (16/100) were positive for EHP: 10% of zoea (1/10), 13.3% of mysis (2/15), and 17.3% of post-larvae (3/75). A total of 13 (81%) samples produced positive results only in the nested PCR step, indicating low-intensity infections, while 3 (19%) samples were positive in the first PCR step, suggesting a high pathogen load. Histopathology revealed microsporidian lesions in hepatopancreatic tissues, including basophilic spore stages, tubular degeneration, and epithelial sloughing. Some larvae exhibited histopathological changes despite being PCR negative, likely due to limitations in DNA recovery from the resistant chitinous spore wall. Detection of EHP across larval stages and hatcheries indicates potential vertical and horizontal transmission. This report of EHP in early larval stages of *L. vannamei* in Sri Lanka emphasises the importance of hatchery-level surveillance. Integrating molecular and histopathological screening into routine monitoring can limit disease transmission. Further studies should refine DNA extraction and expand prevalence surveys to strengthen biosecurity.

Keywords: *Litopenaeus vannamei*, shrimp larvae, *Enterocytozoon hepatopenaei*, hatchery surveillance, Sri Lanka

*Corresponding author email: anilwkalupahana@yahoo.com

Comparative analysis of morphological, morphometric and physiological traits in green mussels (*Perna viridis*) from Negombo Lagoon and Kinniya Bay, Sri Lanka

R.M.P.S. Bandara^{1*}, M.A.J.C. Mallawa Arachchi², Shamali Rathnasri¹ and H.M.S.K. Herath²

¹Department of Coastal and Marine Resources Management, Faculty of Engineering and Management, Ocean University of Sri Lanka, Colombo 15, 01500, Sri Lanka

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

Green mussels (*Perna viridis*) are filter-feeding bivalves in tropical coastal ecosystems and are adaptable to diverse environmental conditions. Comprehensive research is needed to determine how water quality in their natural habitat on their physiological traits. This study aimed to examine morphometric and physiological variations in mussel populations from two contrasting coastal sites in Sri Lanka: nutrient-enriched Negombo lagoon and less contaminated Kinniya bay at Trincomalee. Water quality monitoring was conducted monthly from February to July 2025 at four sampling points per site, measuring temperature, pH, salinity, dissolved oxygen, conductivity, turbidity, nutrients (nitrate, nitrite, phosphate), and chlorophyll a. From 300 collected individuals (150 per site), 65 mussels per site were randomly selected for morphometric analysis of Shell length, width, thickness, and weight, and fresh tissue weight. Condition Index and Shell Shape Index were calculated. Negombo lagoon exhibited substantially higher nutrient and chlorophyll-a levels (phosphate: 0.40 ppm, nitrate: 1.60 ppm, chlorophyll-a: 3.1 µg/L, salinity: 27.6 PSU) compared to Kinniya Bay (phosphate: 0.07 ppm, nitrate: 0.25 ppm, chlorophyll-a: 1.5 µg/L, salinity: 23.7 PSU). Mussels from Negombo lagoon showed significantly higher condition index (61.17 ± 14.26) than Kinniya (28.76 ± 9.93) ($t = 15.04$, $p < 0.001$), reflecting enhanced physiological status coinciding with elevated food availability. Shell shape index shows no significant difference ($p = 0.154$), indicating morphological stability. Correlation analyses revealed contrasting patterns: in Kinniya Bay, salinity ($r = -0.396$, $p = 0.001$) and turbidity ($r = -0.360$, $p = 0.003$) significantly correlated with condition index, while no significant correlations emerged in Negombo. These results demonstrate that mussels from nutrient-enriched environments with higher chlorophyll-a exhibit enhanced physiological performance, suggesting food availability as the primary driver of condition in these populations.

Keywords: Condition index, morphology, nutrients, *Perna viridis*, water quality

*Corresponding author email: piumalsachinthana98@gmail.com

Investigate existing barriers and mitigation strategies to develop an effective fish feed manufacturing industry for Small and Medium Enterprises (SMEs) in Sri Lanka

K.D.P.M. Kariyawasam¹, R. Weerasingha^{2*}, H.K.G.S. Ranasinghe¹ and L.H.T.D. Wickramasuriya¹

¹*Department of Entrepreneurship, Faculty of Management Studies & Commerce, University of Sri Jayewardenepura, Sri Lanka*

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

Sri Lanka's aquaculture industry is mostly dependent on imported aqua feeds, which creates significant cost inefficiencies and exposes the sector to global price volatility. In 2022, imported feed volumes reached approximately 23,600 metric tons, compared to only 1,214 metric tons produced locally, resulting in a foreign exchange following exceeding LKR 7 billion and limiting the growth of SME-led local feed manufacturing. Despite the recognised potential of small and medium enterprises to contribute to feed self-sufficiency, their progress has been constrained by structural, financial, and policy-related barriers. This study investigates the perceived barriers affecting the effectiveness of SME-led fish feed production in Sri Lanka and explores mitigation strategies supported by industry stakeholders. The research applies a dual theoretical framework, combining the Resource-Based View (RBV) to evaluate internal capability gaps such as workforce skills and organisational resources, and the Theory of Constraints (TOC) to examine external challenges, including supply chains, raw material access, and regulatory systems. A quantitative perception-based approach was employed, using a structured questionnaire distributed to 60 stakeholders representing feed manufacturers, fish farmers, raw material suppliers, importers, and government officials. Data were analysed using Partial Least Squares Structural Equation Modelling (PLS-SEM) in SmartPLS 4 at a 5% level of significance to test hypothesised relationships between identified barriers and perceived effectiveness. Findings reveal that economic and financial barriers ($\beta = -0.361$, $p < 0.05$), raw material barriers ($\beta = -0.284$, $p < 0.05$), and regulatory/policy barriers ($\beta = -0.247$, $p < 0.05$) exert a significant negative impact on perceived effectiveness, explaining 32.9% ($R^2 = 0.329$) of the total variance. Human resource barriers showed a positive association, reflecting adaptive practices within SMEs. Technological barriers were not statistically significant, indicating that other barriers, particularly economic, financial and regulatory/policy constraints, had a stronger overall influence on perceived effectiveness. Among the eleven mitigation strategies identified, stakeholders ranked reducing import duties and providing financial incentives as the top priorities, followed by strengthening government-led R&D and simplifying regulatory processes. The study concludes that targeted policy reforms, improved access to inputs, and selective capacity-building are essential for strengthening SME-led feed manufacturing. Addressing these issues will reduce import dependence, safeguard foreign exchange, and contribute to building a resilient, competitive, and sustainable aquafeed industry in Sri Lanka.

Keywords: Fish feed manufacturing, SMEs, perceived effectiveness, barriers, mitigation strategies

*Corresponding author email: rochanaweerasingha@gmail.com

Development of morphological and functional features of local *Artemia* sp. vs. imported *Artemia* sp. nauplii

W. A. C. Madusha¹, R. Weerasingha^{2*} and E. P. D. N. Thilakarathne¹

¹*Faculty of Animal Science and Export Agriculture, Uva Wellassa University, Sri Lanka*

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

Artemia sp. (brine shrimp) are widely utilised as live feed in aquaculture, and understanding strain-specific growth and reproductive characteristics is essential for improving culture efficiency. This study compared a locally cultivated *Artemia* population from the Artemia Production Rural Fisheries Society (APRFS), Puttalam, with imported RED TOP[®] *Artemia* to evaluate differences in life cycle progression, growth, survival, and reproductive timing. Experiments were conducted using 500 nauplii per tank at 35 ppt salinity, with three replicates per strain. Daily microscopic and quantitative assessments were performed over 21 days. Statistical analysis (one-way ANOVA) revealed a significant difference in body length gain between the two strains, with the local *Artemia* strain achieving greater body length ($p = 0.001$). Weight gain did not differ significantly ($p = 0.517$), indicating comparable biomass accumulation under identical conditions. Survival showed a highly significant difference ($p < 0.001$), with the local strain maintaining consistently higher survival rates. Developmental observations indicated that although REDTOP[®] nauplii were slightly larger at hatching, the local *Artemia* exhibited faster morphological progression, earlier thoracopod development, and attained reproductive maturity sooner (mating observed at 11 ± 0.5 days vs. 13 ± 0.5 days in the Redtop strain). These results demonstrate that the local *Artemia* sp. strain possesses superior growth efficiency, higher survivability, and earlier reproductive onset, reflecting strong adaptability to the culture environment. The local *Artemia* therefore represents a robust and promising live feed resource for sustainable aquaculture. Future research should prioritise nutritional profiling, stress-tolerance evaluation, and the optimization of feeding strategies for large-scale production.

Keywords: Local *Artemia*, RED TOP[®] *Artemia*, length, maturity and live feed

*Corresponding author email: rochanaweerasingha@gmail.com

The efficacy of *Ipomoea aquatica* derived phenolic compounds as an antimicrobial agent against different pathogenic bacteria

W.D.C. Rangika*, S. Gallage and S. Jayakody

Department of Aquaculture and Fisheries, Faculty of Livestock, Fisheries and Nutrition, Wayamba University of Sri Lanka, Makandura, Gonawila NWP, Sri Lanka

Ipomoea aquatica, commonly known as water spinach, is a semi-aquatic plant valued in many Asian countries for its nutritional benefits and traditional medicinal uses. This study explores the antimicrobial properties of phenolic compounds extracted from the leaves and stems of *I. aquatica*, targeting a variety of pathogenic bacteria relevant to food safety and aquaculture. Phenolic compounds were extracted using 80% ethanol and quantified through the Folin-Ciocalteu method. The antimicrobial activities of these compounds were assessed at 5 mg/mL using the agar well diffusion assay. 80% of ethanol alone served as the negative control, while Erythromycin and Azithromycin served as positive controls. The pathogen examination included foodborne bacteria such as *Escherichia coli*, *Salmonella typhi*, and *Staphylococcus aureus*, as well as fish pathogens consisting of three *Vibrio* spp. (Vp1, Vp2, Vp3) and *Staphylococcus* spp. isolated from fish. The phenolic content was measured at 12.76 ± 0.63 mg GAE/g in leaf extracts and 13.10 ± 0.45 mg GAE/g in stem extracts. Leaf extracts exhibited a significantly higher antimicrobial activity ($p < 0.001$) against fish pathogenic bacteria than the stem extract. The mean inhibition zone diameters for the leaf extract were 10.66 ± 0.57 mm, 10.33 ± 0.57 mm, 11.33 ± 0.57 mm, and 10.33 ± 0.57 mm against Vp1, Vp2, Vp3, and *Staphylococcus* sp., respectively. The stem extract showed activity only against Vp1 and Vp3. For foodborne pathogens, the leaf extract showed a mean inhibition zone diameter of 10.33 ± 0.57 mm against *Staphylococcus aureus*, 10 ± 0 mm against *Escherichia coli*, and 13.66 ± 1.52 mm against *Salmonella typhi*. Positive controls consistently resulted in inhibition zones >13 mm for all tested bacteria. Notably, *Salmonella typhi* was the most susceptible bacterium to the leaf extract. Overall, these findings highlight the potential of *I. aquatica*-derived phenolic compounds as an effective natural antimicrobial agent, supporting their possible application in the food industry and aquaculture.

Keywords: antimicrobials, fish pathogens, foodborne pathogens, *Ipomoea aquatica*, phenolics

*Corresponding author email: chamodirangika777@gmail.com

Post Harvest Technology

Circular economy approach to fisheries waste: Saponin from sandfish (*Holothuria scabra*) as a natural soap ingredient

G.A. Parami Ranthilini* and D.C.T. Dissanayake

Department of Zoology, Faculty of Applied Sciences, University of Sri Jayewardenepura, Gangodawila, Nugegoda.

A significant amount of organic waste is generated during the processing of sandfish (*Holothuria scabra*) into *beche-de-mer*, a high-value sea cucumber product in the global market. Sandfish capture fisheries and aquaculture are widely practised along the northern coast of Sri Lanka, where processing wastes are often discarded into nearby coastal environments, resulting in ecological degradation and economic loss. This study investigates the potential utilisation of sandfish processing waste, specifically eviscerated viscera (including gonads, gut, and respiratory tree) and processing water, as a source of bioactive compounds, particularly saponins, a class of glycosides with amphiphilic, surfactant, and antimicrobial properties. Sandfish processing wastes were collected from the sea cucumber processing plants in Jaffna between May 2024 and April 2025. Following initial quantification of waste, saponins were extracted from the visceral organs using a methanol-based maceration method and from processing water using an ethanol extraction method. Crude saponins were characterised using FTIR-ATR and HPLC, and quantified gravimetrically. To explore the practical applications, a prototype soap incorporating saponins was developed. Visceral waste accounted for 40.44% of the total catch, with the gut contributing the highest (33.81%). FTIR-ATR confirmed characteristic functional groups of saponins, while HPLC tentatively identified six non-sulfated saponins: Holothurinoside A, C, G, I, Desholothurin A, and A₁. Among visceral organs, gonads yielded the highest crude saponin content (2.93 ± 0.03 g/100 g), whereas overall, the highest yield was obtained from boiled water samples (10.56 ± 0.02 g/100 mL). The soap prototype demonstrated acceptable organoleptic properties, appropriate pH, foam stability, and cleaning efficiency, along with low production cost (74.49 LKR). These findings highlight the potential of valorising sea cucumber processing waste to produce value-added products, promoting a circular economy approach. This aligns with national and global strategies for a sustainable blue economy and advances the concept of zero-waste.

Keywords: *Holothuria scabra*, Saponin, Sea cucumber processing waste, Surfactant, Zero-waste

*Corresponding author email: paramiranthilini@gmail.com

Production and quality evaluation of fish glue from Sailfish Skin (*Istiophorus platypterus*) under different pretreatment conditions

A. R. W. Mohottala^{1*}, K. Radampola², and D. Wijesinghe³

Department of Aquaculture, Faculty of Fisheries and Marine Sciences & Technology, University of Ruhuna, Matara, Sri Lanka

Fish glue is an adhesive derived from fish processing by-products and represents a valuable value-added product. This study aimed to produce fish glue from the skin of sailfish (*Istiophorus platypterus*) using different alkali (NaOH) and acid (HCl) pretreatment concentrations. Three treatments were applied: 1CC (0.1% NaOH and HCl concentration), 2CC (0.2% NaOH and HCl concentration), and 3CC (0.3% NaOH and HCl concentration) at 1:3 (w/v) ratios. Cleaned fish skin was soaked in the respective NaOH and then in HCl solutions, rinsed with distilled water, then heated and filtered; the filtrate was reheated to obtain glue. The resulting glues were evaluated for yield, proximate composition, physicochemical properties, curing time on different substrates, colour, and odour. The best-performing glue sample was compared with a commercial fish glue. Results showed that the 2CC sample produced the highest yield% (76.51 ± 1.55), lowest moisture content ($69.36 \pm 1.61\%$), highest protein content ($28.38 \pm 0.52\%$), highest open time (106.11 ± 10.83 min), and shortest time to tack (1.01 ± 0.12 min). pH of glue (3.52 ± 0.17 to 4.48 ± 0.11) increased with increasing chemical concentration. Density did not differ significantly between 1CC (1.03 ± 0.002 g/cm³) and 2CC (1.03 ± 0.004 g/cm³), but was higher in 3CC (1.07 ± 0.006 g/cm³). The lowest curing time for wood (10.56 ± 1.01 h), glass (16.00 ± 0.00 h), styrofoam (8.00 ± 0.00 h), and cardboard (4.16 ± 0.14 min) was achieved for the 2CC sample. The ideal colour of fish glue was observed in 1CC and 2CC samples, while odour intensity decreased with increasing chemical concentration. Based on quality parameters, the 2CC treatment produced the best glue, which shows comparable characteristics to the commercial fish glue except for solid and moisture content.

Keywords: Alkali and acid pretreatment concentration, fish glue, *Istiophorus platypterus* skin, quality indicators

*Corresponding author email: anushiarw@gmail.com

Development and characterisation of a seaweed (*Kappaphycus alvarezii*) -chitosan-based biopolymer film incorporating coconut water and coconut vinegar

K.L.A. Chamoda¹, D. S. Ariyaratna^{2*}, S. S. Daundasekara¹, and M.R. Perera²

¹ *Department of Food Science and Technology, Faculty of Agriculture, University of Peradeniya, Peradeniya 20400, Sri Lanka*

² *Institute of Post-Harvest Technology, National Aquatic Resources Research and Development Agency (NARA), Crow Island, Colombo 15, Sri Lanka*

The environmental impact of petroleum-based plastics has driven the need for sustainable, biodegradable packaging materials. This study investigated the potential of producing biopolymer film using whole seaweed gel from *Kappaphycus alvarezii*, a rich source of carrageenan, combined with chitosan, a biopolymer derived from chitin. Additionally, the study examined the impact of incorporating mature coconut water (CW) and coconut vinegar (CV) as natural solvents on the properties of the biopolymer film. Films were prepared using an optimised 9:1 volume ratio of 2% (w/v) *K. alvarezii* gel to 1% (w/v) chitosan solution (in 2% acetic acid), with CW and CV added separately at percentages ranging from 10% to 50% (v/v). The resulting films were evaluated for thickness, transparency, water vapour permeability (WVP), tensile strength, and elongation at break (EAB). Both the type and concentration of solvent significantly affected the film properties ($p < 0.05$). Increasing CW or CV levels led to notable increases in film thickness, solubility, and WVP, while transparency and tensile strength decreased. Compared to CW, CV incorporated films were significantly thicker, more soluble, and more permeable, but with reduced tensile strength and EAB. Films with 10% CV had the highest tensile strength (7.47 ± 0.94 MPa) and the lowest EAB ($3.75 \pm 0.86\%$), whereas films with 50% CV were the thickest (0.17 ± 0 mm), least transparent, and most permeable. Films with CW generally showed higher EAB and lower WVP than their CV counterparts at equivalent percentages. In conclusion, incorporating CW or CV into *K. alvarezii*-chitosan films allows for targeted property modification, where CW enhances flexibility, while CV increases thickness, WVP, and solubility but reduces tensile strength and flexibility at higher solvent percentages.

Keywords: *Kappaphycus alvarezii* Seaweed, chitosan, coconut water, coconut vinegar, biopolymer film

*Corresponding author email: headipht@gmail.com

Towards a circular economy in fisheries: Eco-crafts from the skin of triggerfish (*Canthidermis maculata*)

S. Karunarathne, N.M.S. Jayasekara*, V.D. Samaraweera, and D.C.T. Dissanayake

*Department of Zoology, Faculty of Applied Sciences, University of Sri Jayewardenepura,
Gangodawila, Nugegoda, Sri Lanka*

Triggerfish, belonging to the family Balistidae, are widely distributed throughout the Indian, Pacific, and Atlantic Oceans. In Sri Lanka, they are primarily landed as bycatch in the ring net fishery. More than 90% of the landed triggerfish are processed into dried fish, a practice that generates considerable waste, including heads, skin, and viscera. This study aims to quantify the processing waste and explore the potential of value addition to triggerfish (*Canthidermis maculata*) skin by utilising its unique structural properties as a raw material for the production of eco-friendly, fashionable, and marketable products. Data were collected through fortnightly visits to the dried fish-processing site on Sea Street, Negombo, from May 2023 to April 2024. The distinctive, thick, and paper-like skin of triggerfish, which is usually discarded as waste, was processed into a leather-like material using both single and dual tanning methods with tea and Indian almond leaf extracts (25%, 50%, and 100%) as well as $\text{Cr}_2(\text{SO}_4)_3$. The mechanical properties of the resulting leather-like material were evaluated, and the material was subsequently utilised as a raw material for handcrafted, fashionable products. Processing *C. maculata* into dried fish generated approximately 35% waste, of which 23% consisted of fish heads and 10% was skin. Fish skin treated with 100% Indian almond leaf extract using the dual tanning method produced high-quality fish leather, exhibiting the highest mechanical properties, including tensile strength ($9.84 \pm 0.45 \text{ N mm}^{-2}$), elongation ($28.27 \pm 0.38\%$), and tear strength ($25.81 \pm 0.41 \text{ N m}^{-1}$), compared to other treatments. The processed fish leather was successfully crafted into ornaments and accessories such as wallets, earrings and foot wear. This study highlights the potential for valorising triggerfish skin by converting it into fish-leather, thereby promoting waste recycling, enhancing value addition, and creating eco-friendly market opportunities. This innovation not only promotes waste recycling and value addition but also creates eco-friendly market opportunities.

Keywords: Eco-crafts, fish leather, tanning, triggerfish, valorisation

*Corresponding author email: *madhavisulochana97@gmail.com*

Evaluation of pretreatment techniques for enhancing textural properties of dried sea cucumber (*Holothuria scabra*) muscle for food applications

W.T.N. Rodrigo¹, N.M. Wijesundara² and A.S. Mahaliyana¹

¹Department of Animal Science, ²Department of Food Science and Technology, Faculty of Animal Science and Export Agriculture, Uva Wellassa University, Badulla 90000, Sri Lanka

Sea cucumber (*Holothuria scabra*) is a highly nutritious marine food resource with potential medicinal benefits. Dried sea cucumbers, known as Bêche-de-mer, are an important economic asset for many Asian countries, including Sri Lanka. However, despite their export potential, the inherently tough and rubbery texture of dried sea cucumber limits their acceptance in diversified food applications and restricts opportunities for value-added products. This study aimed to evaluate and identify the optimal pretreatment technique to improve the tenderness of dried sea cucumber muscle to enhance its suitability for food product development. Dried sea cucumbers were soaked for 24 hours for rehydration and then subjected to four different pretreatments: papaya peel powder marination (8% w/w), pineapple peel powder marination (8% w/w), sodium bicarbonate (NaHCO₃) emulsion (2% w/w), and steam treatment at 100°C. Texture analysis (TexturePro CT V1.8 system) and sensory evaluation were performed to determine the optimal treatment. The texture profile analysis was performed on both treated and control samples to measure hardness, resilience, adhesive force and springiness. Sensory evaluation assessed tenderness, springiness, cohesiveness, and shear force, with results analysed using the Friedman test. The findings indicated that pineapple peel marination was the most effective in increasing deformation (2.08 mm) and springiness (3.73 mm). A statistically significant difference ($p \leq 0.05$) was observed in mean tenderness, with pineapple peel marination yielding the highest mean value (4.07 ± 0.23). Mean springiness also differed significantly ($p \leq 0.05$), with sodium bicarbonate emulsion yielding the highest value. No significant differences were observed among the treatments for other sensory attributes ($p \leq 0.05$). Overall, pineapple peel marination emerged as the most effective pretreatment for enhancing the textural quality of dried sea cucumber. The identified pretreatment method provides a practical approach to improving the texture of dried sea cucumber, supporting future development of value-added products for the Sri Lankan food industry.

Keywords: beach-de-mer, hardness, marination, tenderness, pretreatment

*Corresponding author email: sachintha@uwu.ac.lk

Development of a value-added fish ball product using Catla (*Catla catla*) mince and tuna (*Thunnus spp*) black flesh for sustainable fishery

P.N.V.M. Arachchi¹, D.S. Ariyaratna^{2*}, W.A.A.D.L. Wikramasinghe¹, B.A.N. Indika Bamunurachchi¹, Ruchitha Perera², and P. Sahitharakshana²

¹*Department of Aquaculture and Seafood Technology, Ocean University of Sri Lanka, Colombo 15, Sri Lanka*

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

Black meat tuna is a by-product of the tuna export industry with low market value. Due to its dark colour, strong flavour and odour. This study aimed to develop a value-added fish ball product by incorporating black meat Tuna (*Thunnus spp.*) with Catla (*Catla catla*) mince to achieve acceptable sensory properties. Six initial formulations with different Tuna to Catla ratios (100:0, 60:40, 40:60, 20:80, 80:20, 0:100) were developed and evaluated by sensory evaluation. The 20:80 ratio was identified, acceptable and was used to develop the final fish ball recipe. The fish balls were vacuum packed, cooked in a water bath for 10 minutes and subjected to sensory evaluation and storage trials under -18°C. In a comparative test with a leading commercial product, the developed fish ball showed no significant difference in overall acceptability. Proximate analysis showed protein (18.23%) and fat (4.52%) content, Moisture (68.48%), and ash (2.15%). During five weeks of frozen storage, the product maintained good quality, with pH 5.89, TVB-N 3.15 mg/100g, and peroxide value 2.60 meq O₂/Kg. Microbiological analysis confirmed that the Total plate count was <10cfu/g and the absence of pathogenic organisms such as *Listeria* and *Salmonella*. Overall, the findings demonstrate that tuna black meat can successfully be utilised to produce a sensory-acceptable, safe and market-competitive fish ball product, offering a promising avenue for value addition in the tuna industry.

Keywords: Fish Ball, *Catla* mince, tuna black meat, sensory evaluation, By-product

*Corresponding author email: asuseema@hotmail.com

Development of a functional breakfast cracker incorporating *Gracilaria verrucosa* sp. (sea moss)

H.A.S.V. Attanayke¹, D.S. Ariyaratne^{2*}, W.A.A.D.L. Wikramasinghe¹, M. Ruchitha Perera², H.M.S.M. Wijesinghe¹, and P. Sahitharakshana²

¹*Department of Aquaculture and Seafood Technology, Ocean University of Sri Lanka, Colombo 15, Sri Lanka*

²*Department of Institute of Post-Harvest Technology, National Aquatic Resources Research and Development Agency (NARA), Crow Island, Colombo 15, Sri Lanka*

Global market demand for healthy, functional, and sustainable snacks has led to the application of marine bio-resources such as seaweed in bakery foods. *Gracilaria* sp. (seaweed) is a red seaweed that contains dietary fibre, minerals, and bioactive compounds and hence has high potential as a functional ingredient. The present study aimed to develop a breakfast cracker that is enriched with *Gracilaria* sp. (10% Seaweed powder) and organic ingredients and evaluate its nutritional, physicochemical, textural, microbial, and sensory properties. The organic ingredients include wheat flour, corn flour, cinnamon, sesame seeds, herbal oil, sugar, and salt. The experimental design included formulations containing 5%, 10%, 15%, and 20% seaweed powder combined with other ingredients and 10% was selected according to the results of sensory evaluation. Proximate analysis showed 0.0231 water activity, 8.36% moisture, 8.37% protein, 11.6% fat, 2.33% ash, 5.44% dietary fibre, and 66.18% carbohydrates. Texture results showed hardness (2.693 g), gumminess (2435.00 g), and chewiness (227.80 mj). Sensory evaluation showed that 75% of the panellists liked the product extremely. The final product was free from *Escherichia coli*, *Salmonella spp.*, and *Staphylococcus aureus*. The aerobic count and yeast/mould were all less than 10¹ CFU/g during the first two months. Due to the high nutritional value of *Gracilaria* sp., incorporating it into the cracker improves the nutritional quality of the cracker, making it a quality breakfast choice that includes supplementary dietary-relevant fibre for people. Based on its nutrient composition (66.8% carbohydrates, 8.1% protein, and 25.1% fat), the cracker provides about 526 kcal per 100 g, offering a good source of energy that can support the daily nutritional needs of consumers.

Keywords: seaweed cracker, *Gracilaria* sp., healthy food, sensory evaluation

*Corresponding author email: asuseema@hotmail.com

Addressing food safety from sea to the plate: determination of formaldehyde in fish using Nash's method

A.G.B.E.U. Wickramanayake¹, N.H.P. Perera¹, K.M.M.M. Karunathilaka¹, B.A.P.R.N. Jayawardhana¹, T.M.V. Madhubhashini¹, Y. Rasanjanee¹, and G.D.T.M. Jayasinghe^{2*}

¹Department of Biomedical Science, Faculty of Health Sciences, KIU, Battaramulla, Sri Lanka

²Institute for Combinatorial Advanced Research & Education, General Sir John Kotelawala Defence University, Ratmalana, Sri Lanka

Fish is a key source of dietary protein in the Sri Lankan diet, serving as an important provider of a wide range of essential micronutrients. However, the safety of this commodity is undermined by the common use of poor handling, poor storage facilities, and the clandestine use of chemical preservatives, most notably formaldehyde. Formaldehyde is a carcinogenic agent and can pose a significant public health risk when it is ingested via polluted fish. Accordingly, the present study was aimed at quantifying formaldehyde levels using a validated method in five widely marketed fish species [Shark (*Carcharhinus sp.*), Yellowfin Tuna (*Thunnus albacares*), Spanish Mackerel (*Scomberomorus commersoni*), Sailfish (*Histiophorus gladius*), and Trevally (*Caranx stellatus*)] purchased from the fish markets of Galle, Beruwala, and Negombo by means of a spectrophotometric analytical protocol using Nash's reagent. Accordingly, 30 specimens were collected, and each sample was homogenised in 5 % trichloroacetic acid (TCA), and the pH was subsequently adjusted to 6.0 - 6.5 using potassium hydroxide (KOH). Each sample was analysed in triplicate to ensure accuracy and reproducibility of the results. Nash's reagent was then introduced to catalyse the formation of diacetyldihydrolutidine (DDL), which was quantified using a UV-Visible spectrophotometer at 412 nm. An experimental calibration curve (0-24 µg/mL) with an $R^2 \sim 0.99$ enabled the precise quantification of formaldehyde concentrations. The intraday and interday RSD values were below 20 %, with recovery percentages ranging from 90 % to 110 %. The LOD and LOQ values were 0.01 µg/g and 0.04 µg/g. Accordingly, the method was successfully validated, confirming its reliability and suitability for formaldehyde determination in fish samples. The highest levels were recorded in shark from Galle (2.63 ± 0.07 µg/g) and in Yellowfin tuna from the same market (6.25 ± 0.36 µg/g). In Negombo, shark showed the highest concentration (4.12 ± 0.13 µg/g), while in Beruwala, Yellowfin tuna led with 3.79 ± 0.28 µg/g. Trevally and sailfish from Beruwala showed comparatively low levels, at or below 1 µg/g. According to the generally accepted standard limit of 5 µg/g for naturally occurring formaldehyde in fish, the Yellowfin tuna from Galle exceeded this permissible level, indicating possible external contamination or elevated natural accumulation. The results also highlight the urgent need for consistent monitoring and stricter enforcement throughout Sri Lanka's fish supply chain for formaldehyde contamination.

Keywords: formaldehyde, fish, spectrophotometry, food safety, public health

*Corresponding author email: jayasinghe.g@kadu.ac.lk

Shelf stability assessment of cold-smoked fish burger produced with rough trigger fish (*Canthidermis maculata*)

N.A.S.N.S. Nishshanka¹, D.S. Ariyaratna^{2*}, K.K.A. Sanjeewa¹, and M.R. Perera²

¹*Department of Biosystems Technology, Faculty of Technology, University of Sri Jayewardenepura, Sri Lanka*

² *Institute of Post-Harvest Technology, National Aquatic Resources Research and Development Agency (NARA), Crow Island, Mattakkuliya, Colombo 15, Sri Lanka*

The Rough Triggerfish (*Canthidermis maculata*), commonly known as “Muhudu kukula,” is an abundant fish species, primarily used for the production of dried fish due to its low market value. This study aims to increase the marketability of fish through value addition, such as burger patties and cold-smoked products, to enhance the flavour. The most acceptable formulation was selected through sensory evaluation. Cold-smoking was done for approximately 40 minutes at a temperature of 25 to 30 °C to enhance the flavour. Vacuum-packed (VP) and polythene-packed (PP) samples were stored under frozen conditions at -18 °C. Both smoked and non-smoked samples were used for the storage trial. The quality and safety changes of the product during storage were assessed through microbiological, chemical, and sensory evaluations conducted at 15-day intervals. The texture profile analysis was determined using AOAC methods. The proximate composition of the final product was 57.4 ± 0.51% moisture, 21.87 ± 2.33% protein, 7.01 ± 2.33% fat, and 3.59 ± 0.08% ash. The product was also free from *Escherichia coli*, *Salmonella spp.*, and *Staphylococcus aureus*. During the storage trial, the pH value, moisture content, decreased to 5.91 ± 0.01, 56.51 ± 0.48 %, and hardness increased to 847.50 ± 42.50g, while the total volatile base nitrogen values increased to 16.17 ± 3.43 mg N/100g. The total aerobic plate count was increased for both smoked and non-smoked (38×10³ CFU/g and 14×10³ CFU/g). According to the sensory and microbiological analysis, the shelf life of the product can be extended up to 60 days under -18°C frozen storage. The analysis was done by Duncan's Multiple Test using SPSS software 27. This study reveals the feasibility of producing fish burger patties with desirable sensory and nutritional characteristics by using Rough Trigger fish and thereby increasing the demand for seafood.

Keywords: Smoked fish burger, cold smoking, rough triggerfish, proximate analysis, vacuum packaging

*Corresponding author email: headipht@gmail.com

Preparation of fish silage using Skipjack tuna (*Katsuwonus pelamis*) waste by different techniques

E.D.T.S. Rajakaruna*, K. Radampola, and R.D.N. Wijesinghe

Department of Fisheries and Aquaculture, Faculty of Fisheries and Marine Sciences & Technology, University of Ruhuna.

The global marine fishery sector has expanded in recent years, increasing fish waste. Skipjack tuna is one of the commercially important species and is widely distributed in tropical and subtropical waters, occasionally extending into warm temperate waters. During fish processing at markets, harbours, and processing factories, large quantities of solid waste are generated through viscera, gills, fins, de-heading parts, skin, and bones. Fish waste from Skipjack tuna was collected from Dondra Fisheries Harbour. This study investigated the preparation of fish silage from Skipjack tuna waste using three different techniques: Bio-fermentation (BF) (7.5% sugar cane molasses, 2.5% yoghurt as a lactic acid bacteria source, and 0.2% potassium sorbate), Inorganic acid treatment (IT) (2.5% v/w 95% sulfuric acid), and Organic acid treatment (OT) (3.5% v/w 98% formic acid). Proximate analysis was done for fish waste and the prepared silage samples. The initial proximate composition of tuna waste was $43.14 \pm 0.39\%$ crude protein (CP), $29.67 \pm 0.57\%$ lipid, $27.10 \pm 0.16\%$ ash, and $70.78 \pm 0.41\%$ moisture. During fermentation, pH declined gradually in bio-fermented (4.16 ± 0.15) and organic acid (3.80 ± 0.16) treatments, while in the inorganic acid treatment, pH rapidly dropped to 3.10 ± 0.02 . After one month, the nutritional composition varied across treatments. The CP levels were $39.10 \pm 0.19\%$, $32.69 \pm 1.22\%$ and $26.41 \pm 0.50\%$ for BF, OT and IT, respectively. Lipid levels were 10.35 ± 0.61 , 6.66 ± 1.07 , and 3.84 ± 0.40 for BF, OT, and IT, respectively. Ash contents ranged from 20.88 ± 0.98 to 30.26 ± 0.57 . The bio-fermented treatment was found to be the most suitable method for preparing fish silage based on its higher nutritional value compared to the other two treatments.

Keywords: Skipjack tuna, fish market waste, fish silage, fish waste utilisation

*Corresponding author email: subodikathilini@gmail.com

An assessment of sanitary conditions and microbial quality of ice factories in selected districts of Sri Lanka

A.D.D.S. Perera¹, P.H. Ginigaddarage², G.P. Roshan², G. Gunasekara², S. Kirushanthan¹ and R.A.S.S.Ranasinghe^{2*}

¹*Department of Agricultural Chemistry, Faculty of Agriculture, University of Jaffna, Jaffna. Sri Lanka. 4000.*

²*Institute of Post-Harvest Technology, National Aquatic Resources Research and Development Agency (NARA), Crow Island, Colombo 15, Sri Lanka*

Ice is crucial for maintaining the freshness and quality of seafood. However, when produced or handled under poor sanitary conditions, ice can carry harmful microorganisms, creating risks to food safety and public health. This study aimed to assess the microbial quality of ice produced in 28 ice plants across eight districts: Galle, Matara, Hambantota, Trincomalee, Anuradhapura, Mannar, Batticaloa, and Jaffna. The sample collection was conducted over 2 months from July to August 2025. Samples were collected from three points in each factory: source water used for ice production, stored block ice, and crushed ice to identify contamination sources or points/steps at different production stages. Microbial analysis was conducted to detect *Escherichia coli* (SLS 1461 Part 1/Sec.3:2013) and *Salmonella* (ISO 19250:2010). The results showed that all three samples taken from the production lines of four ice plants had an acceptable microbial quality, as indicated by 14.29 % (4/28) of the samples meeting the standards outlined in SLS 971:1992 for potable water. A number of 28 ice plants indicated that 85.71 % (24/28) were unacceptable in quality due to the presence of *E. coli*. Among these 24 plants, the water used for ice production in 14 facilities contained faecal coliforms with a mean of 144.96 MPN/100 mL and a median of 9.5 MPN/100 mL, and in the range of 1 to >1,800 MPN/100 mL, and 13 facilities exhibited the presence of *E. coli* contamination with a mean of 22 MPN/100 mL and a median of 2 MPN/100 mL, and in the range of 1 to 1,600 MPN/100 mL. Stored ice of 20 plants contained faecal coliforms between 1 to 350 MPN/100 mL range, and the mean of faecal coliform count was 86.08 MPN/100 mL, and median 15 MPN/100 mL, and 17 plants detected *E. coli* (1 to 275 MPN/100 mL), with a mean and median of 33.08 MPN/100 mL and 9 MPN/100 mL. All crushed ice samples were contaminated with faecal coliforms (1 to 1,600 MPN/100 mL), and the mean was 268.21 MPN/100 mL, and the median was 17 MPN/100 mL, with *E. coli* present in 21 facilities (1 to 1,600 MPN/100 mL), and the mean was 163.38 MPN/100 mL, and the median was 13 MPN/100 mL. All samples were free from *Salmonella*. The study highlights increasing contamination through production stages, linked to poor sanitation facilities and handling practices. Continuous staff training, adoption of good manufacturing practices, and regular monitoring of ice quality are strongly recommended.

Keywords: Ice plants, Microbiological quality, *Escherichia coli*, Faecal coliforms, *Salmonella*

*Corresponding author email: sudeeparanasinghe@gmail.com

Determination of the effectiveness of selected disinfectants against *Klebsiella aerogenes* biofilms

P.H. Ginigaddarage^{1*}, G.J. Ganegama Arachchi¹, K.W.S. Ariyawansa¹, G.P. Roshan¹, J.H. Meepe Arachchi¹, G. Gunasekare¹, and C.M. Nanayakkara²

¹*Institute of Post-Harvest Technology, National Aquatic Resources Research & Development Agency (NARA), Colombo 15, Sri Lanka*

²*Department of Plant Sciences, Faculty of Science, University of Colombo, Colombo 03, Sri Lanka*

Control of microbial population and biofilm removal on food contact surfaces has a direct impact on the spoilage of food products by reducing cross-contamination. Therefore, this study was aimed at evaluating the anti-microbial activity of selected commercial disinfectants used in the fish processing factories and some multiday fishing boats against biofilms formed by *Klebsiella aerogenes*, which is a prolific histamine former. Grade 304 stainless steel (SS) coupons (1 x 1cm) were used as the test surface to examine biofilm formation *in vitro*. Biofilms were formed by placing sterile SS coupons in tubes containing Tryptone Soy Broth and incubating them at 37 °C with constant agitation for 5 days, and confirmed by using scanning electron microscopy. Disinfectants used contained triclosan (A), quaternary ammonium compounds (B), hydrogen peroxide (C) and sodium hypochlorite (D) as active agents at the concentrations: A: 1:20 and 1:10, B:0.1% and 0.2%, C:0.5% and 1%, D:1:20 and 1:10. Quantification of viable bacterial cells was done by culturing in trypticase soy agar at 37 °C for 24-48h. Average log₁₀CFU/cm² values of bacterial count on TS agar showed that there were bacterial cells surviving after the disinfectant treatment on SS coupons. Obtained bacterial counts after the contact time for the above-mentioned concentrations are as follows. Disinfectant A, 4.6963±0.02 and 4.3303±0.02 Log₁₀ CFU/cm²; Disinfectant B, 1.1858 ±0.05 and 0.8386±0.13 Log₁₀ CFU/cm²; Disinfectant C, 2.5806±0.08 and 2.0200±0.20 Log₁₀ CFU/cm²; and Disinfectant D, 1.8164±0.05 and 0.6896±0.25 Log₁₀ CFU/cm². Control had a bacterial count of 4.9712±0.13 Log₁₀ CFU/cm². Results showed that the disinfectant D had a higher reduction percentage (86%) for the 10:1 ratio, whereas 20:1 showed 63.5% of a reduction. The disinfectant B showed a more than 75% of reduction. The reduction of biofilm cells with disinfectant A was minimal, with less than 13%. Disinfectant C had a reduction of 48.1% for the 0.5% concentration and 59.15% for the 1%. Results of bacterial reduction in biofilm cells after the exposure time clearly indicated that the biofilm cells are more difficult to remove than the planktonic cells due to complex structures formed during biofilm formation.

Keywords: *Klebsiella aerogenes*, biofilms, disinfectants

*Corresponding author email: hasangi_g@yahoo.com

A comprehensive assessment of indian scad fish (*Decapterus russelli*) quality used in local canned fish production

A.G.A.P. Sarathchandra¹, D.S. Ariyaratne^{2*} and J.H. Meepearachchi², and P. Sahitharakshana²

¹Department of Food Science and Technology, Faculty of Applied Sciences, Sabaragamuwa University of Sri Lanka, P.O. Box 02, Belihuloya

²Institute of Post-Harvest Technology, National Aquatic Resources Research and Development Agency (NARA), Crow Island, Colombo 15

Indian Scads (*Decapterus russelli*) are the primary species used in canned fish production in Sri Lanka. This study aims to assess the quality of fish by evaluating their physicochemical, microbiological, and sensory properties. A survey was conducted to identify the major fish supply locations, grades and as the second step, the data was collected from fish suppliers. Fresh fish from all the grades were collected from Kudawella and Beruwala harbours (from three suppliers per harbour), for analysis. According to the first survey, the main landing sites were identified as Kudawella, Ambalangoda, Beruwala and Trincomalee. Producers reported primarily using Grade II fish for canned fish production. The survey of fish suppliers revealed that collectors purchase Grade II and III fish, with some also accepting fish with belly damage. Hence, some discrepancies were observed between their responses. Sensory evaluation (in-house method) results indicated a clear decline in freshness from Grade I to Grade IV, both in Kudawella and Beruwala. Grade I (Kudawella: 16.33 ± 0.89 , Beruwala: 17.11 ± 1.76) and Grade II (Kudawella: 12.67 ± 0.88 , Beruwala: 12.56 ± 2.35) were considered as acceptable for human consumption (Reference No: PL/S/MM/001), whereas Grades III (Kudawella: 8.78 ± 1.56 , Beruwala: 9.11 ± 3.32) and IV (Kudawella: 5.67 ± 0.58 , Beruwala: 4.33 ± 1.32) were estimated as unfit for human consumption. Physicochemical analyses showed that grade V samples exceed the recommended limit (Total Volatile Basic Nitrogen (TVB-N) below 35mg/100g), (Kudawella: 37.10 ± 2.21 mg/100g, Beruwala: 39.59 ± 1.51 mg/100g) and trimethylamine (TMA) (Kudawella: 12.61 ± 2.64 mg/100g, Beruwala: 10.52 ± 1.59 mg/100g). However, histamine levels and *Escherichia coli* were present in all the samples and remained within the accepted limits across all grades. Despite being microbiologically and chemically safe, the fish used for canned fish products were rejected based on sensory evaluation, likely causing the low market demand.

Keywords: Indian Scad fish, canned fish, Total volatile base nitrogen, Histamine, *Escherichia coli*

*Corresponding author email: headipht@gmail.com

Aquatic Biotechnology and Animal Health

Optimisation of surface sterilisation and control of oxidative browning during *in vitro* culture of *Bucephalandra pygmaea*

M.A.M.N. Kularathne^{1*}, D.M.S. Sugeeshwari¹, D.M.R.G. Mayakaduwa¹, and W.A.K. Madurangika²

¹Department of Plant Sciences, Faculty of Science, University of Colombo

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

Bucephalandra sp. is a highly demanded aquatic ornamental plant. However, its commercial propagation is hindered by low multiplication rates and limited efficiency in *in vitro* regeneration protocols. The present study aimed to develop an effective protocol for surface disinfection and to control oxidative browning that occurs during *in vitro* growth of *B. pygmaea*. Murashige and Skoog (MS) medium was used as the basal growth medium. Explants were surface disinfected using different concentration of ethanol (AR grade, Merck) and sequential concentrations of Clorox™ (5.25% Sodium hypochlorite) including A0 = 50% ethanol + 8% Clorox, A1 = 50% ethanol + first 8%, then 10% Clorox, A2 = 70% ethanol + first 8%, then 10% Clorox, A3 = 70% ethanol + first 10%, then 15% Clorox, and A4 = 50% ethanol + first 10%, then 15% Clorox, to determine the most effective disinfection protocol for leaf explants (0.5 cm × 0.5 cm). Leaf explants subjected to effective surface disinfection were subsequently cultured on MS medium supplemented with different antioxidant treatments to control tissue browning. Treatments included B0 = control (0 mg/L ascorbic acid), B1 = 50 mg/L ascorbic acid, B2 = 100 mg/L ascorbic acid, B3 = 150 mg/L ascorbic acid, and B4 = 100 mg/L ascorbic acid + 150 mg/L citric acid. Cultures were incubated at 25 ± 2 °C under a 16-hour photoperiod (light intensity 40 μEm⁻² s⁻¹). Among the experiments were conducted according to a completely randomised design (CRD). Each treatment had 6 replications with two leaf explants. The data were analysed using one-way Analysis of Variance (ANOVA) using R software version 4.3.3. Mean comparisons were performed using the Duncan multiple tests at p<0.05. The success of surface disinfection of leaf explants was significantly higher in A3 treatment (83% survival) compared to other treatments. Oxidative browning was effectively controlled in B4 treatment, which resulted in a significantly higher number of healthy explants (83%) compared to other treatments. These findings suggest that the improved response is due to a combination of effective microbial elimination and decreased oxidative stress on the explants. The results provided insights into establishing an effective protocol for *in vitro* multiplication of *B. pygmaea* and highlighted the need for further research to enhance the control of oxidative browning in cultured tissues.

Keywords: Ascorbic acid, aseptic culture, citric acid, explant response, phenolic effect

*Corresponding author email: maheshanirmani@gmail.com

Biochemical and antioxidant assessment of the sea cucumber *Holothuria scabra* from Jaffna, Sri Lanka

H.H.T.A. Sankalpana*, H.P.S. Jayapala, and N.M.G.R. Hansima

Department of Coastal and Marine Resources Management, Faculty of Engineering and Management, Ocean University of Sri Lanka.

This study investigates the bioactive properties and potential therapeutic benefits of the sea cucumber *Holothuria scabra*, harvested from the Jaffna region of Sri Lanka. Sea cucumbers are ecologically significant marine invertebrates known for their rich content of bioactive compounds, which possess antioxidant, anti-inflammatory, antimicrobial, and anticancer properties. Despite their economic importance and growing commercial harvest in Sri Lanka, comprehensive studies on the biochemical composition and pharmacological potential of local *H. scabra* populations remain scarce. Methanol extracts of *H. scabra* were subjected to qualitative phytochemical screening and antioxidant assays. The qualitative phytochemical analysis revealed the presence of saponins, terpenoids, steroidal compounds, and cardiac glycosides, but the absence of tannins and carbohydrates. These metabolites are recognised for a broad range of biological activities, providing a pharmacological basis for potential applications in medicine, nutrition, and cosmetics. Antioxidant capacity measured by the DPPH radical scavenging assay demonstrated notable free radical inhibition by the *Holothuria scabra* extract with an IC_{50} value of 67.17 $\mu\text{g/mL}$, demonstrating moderate antioxidant potential. This activity, while lower than the gallic acid standard ($IC_{50} = 52.07 \mu\text{g/mL}$), falls within the classification for moderate antioxidant capacity (50-100 $\mu\text{g/mL}$). The total phenolic content (TPC) averaged 34.38 mg gallic acid equivalents per gram, using gallic acid as the standard, while the total flavonoid content (TFC) was relatively high at 13.00 mg rutin equivalents per gram, with rutin used as the standard; both contributed significantly to the antioxidant activity. This research fills a critical gap in the Sri Lankan context by providing baseline biochemical and antioxidant data on *H. scabra* from Jaffna. The findings align with global reports on sea cucumber bioactivity and highlight the species' promise as a source of natural bioactive compounds for pharmaceutical, nutraceutical, and functional food industries. Future research should focus on isolating bioactive compounds, conducting in vivo efficacy studies, and performing clinical assessments to confirm the therapeutic potential of *Holothuria scabra* extracts.

Keywords: DPPH assay, total flavonoid, total phenolic, phytochemical screening, sea cucumber

*Corresponding author email: sajeejayapala@gmail.com

Integrative morphological, molecular and eDNA approaches for fish species identification and diversity assessment in the Kalpitiya lagoon

R.M.U.D Rathnayaka¹, S. Yatawaka², D.R. Herath^{2*} and S.M. Young¹

¹ *Department of Environmental Technology, Faculty of Technology, University of Colombo* ²*Marine Biological Resources Division,*

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

Biodiversity in coastal ecosystems, particularly fish diversity, plays a vital role in maintaining ecological stability and ensuring the sustainable use of resources. Kalpitiya Lagoon, situated on the NorthWestern coast of Sri Lanka, is a biologically rich habitat supporting a wide range of fish species, including commercially valuable and cryptic taxa. Limited use of integrative methods has hindered accurate biodiversity assessments in this ecosystem. This study employed a combined approach of morphological identification, DNA barcoding, and environmental DNA (eDNA) analysis to enhance fish species identification and diversity assessment in the lagoon. Fish specimens were first identified morphologically, while ambiguous samples were subjected to DNA barcoding. eDNA obtained from water samples enabled the detection of elusive species without direct capture. DNA from five morphologically challenging species was amplified with universal primers for fish identification, Fish F2 and Fish R2, sequenced, and verified using the NCBI BLAST database. Species initially identified as *Carangoides chrysophrys*, *Gerres oblongus*, *Caranx heberi*, *Lutjanus fulvivflamma*, and puffer fish were reclassified as *Carangoides talamparoides*, *Gerres oyena*, *Caranx ignobilis*, *Lutjanus johnii*, and *Arothron manilensis*. Additionally, eDNA analysis revealed species undetected in direct sampling. Findings highlighted clear discrepancies between morphological and molecular results, with molecular and eDNA tools successfully detecting cryptic taxa that were overlooked by morphological identification. Additionally, eDNA analysis revealed species entirely undetected through direct sampling. While morphological identification proved insufficient on its own, DNA barcoding and eDNA analysis provided greater accuracy, collectively generating a more comprehensive species inventory. The integrative approach applied here demonstrates the value of combining conventional and molecular techniques for reliable biodiversity assessments. These findings not only advance understanding of fish diversity in Kalpitiya Lagoon but also provide a framework for conservation and sustainable management of coastal ecosystems.

Keywords: fish diversity, Kalpitiya lagoon, DNA barcoding, environmental DNA (eDNA), morphological analysis

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

Preliminary genetic evidence for a unique lineage of *Scolopsis xenochroa* from India and Sri Lanka

Y.C. Aluwihare¹, Sulakshi M Koralalage², and R.P. P. K. Jayasinghe¹

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

²Department of Fisheries and Marine Sciences, Faculty of Fisheries and Ocean Sciences, Ocean University of Sri Lanka, Mahawela Road, Tangalle, 82200, Sri Lanka

The genus *Scolopsis* Cuvier 1814 (Perciformes: family Nemipteridae) comprises reef-associated fishes. *Scolopsis xenochroa* has been recorded from the North Eastern, South Eastern and South Western coasts of India and North Western region in Sri Lanka. Genetic sequence information of a particular species is essential to study the evolutionary relationship among different geographical areas. The tissue samples of the *S. xenochroa* specimen, which was collected by the Dr Fridtjof Nasen research vessel in 2018 near the Kalmunai region on the East coast of Sri Lanka, were preserved in ethanol. Morphological features and morphometric counts were recorded using existing keys. The extracted DNA was amplified using FishF1/FishR1 universal primers and sequenced (accession number PX380541). The Phylogenetic analyses were performed in MEGA V10 with this sequence and sequences from different regions extracted from NCBI, GenBank. Morphological features and morphometric counts corresponded with *S. xenochroa*. The sequence of this adult specimen showed 99.8% sequence similarity with the previously submitted *S. xenochroa* egg sequence collected from the Southeast region during the same survey. Four unique single-nucleotide polymorphisms (SNPs) were found between the egg and adult samples. Phylogenetic analysis revealed that Sri Lankan sequences of egg and adult of *S. xenochroa* have 99.7% sequence identity with Indian sequences and clustered into a distinct cluster (group II), and sequences from all other geography regions cluster into a separate cluster (group I). Twelve unique SNPs were detected in Group II, suggesting a distinct Northern Indian Ocean lineage of *S. xenochroa*. A very close evolutionary relationship with evolutionary divergence of 0.007 in Group II, but 0.05 in Group I. Overall, these results suggest a genetically distinct group of *S. xenochroa* in the North Indian Ocean. However, this study used the highly conserved COI marker; therefore, in further studies on comprehensive genetic analysis with a high number of samples, with microsatellite and SNP arrays would provide a comprehensive picture of the genetic makeup of *S. xenochroa* in the coastal area in India and Sri Lanka.

Keywords: *Scolopsis xenochroa*, COI gene, unique lineage, evolutionary divergence

*Corresponding author email: yasminaluwihare@gmail.com

Morphological and molecular identification of lobster species of the Southern Province of Sri Lanka

H.T.D.N.D. Jayakody¹, S. Yatawaka², D.R. Herath^{2*}, and A.R.S.B. Athauda¹

¹ Department of Animal Science, Faculty of Agriculture, University of Peradeniya.

² Marine Biological Resources Division, National Aquatic Resources Research and Development Agency (NARA), Crow Island, Colombo 15, Sri Lanka

The spiny lobster (*Panulirus* sp.) fishery represents a significant economic sector in Sri Lanka, as it is one of the most expensive seafood commodities due to its high market demand. However, comprehensive molecular identification of all available species remains limited in Sri Lanka. This study focuses on the molecular identification of *Panulirus* species found along the Southern coast of Sri Lanka, where five species are known to occur: *P. homarus*, *P. versicolor*, *P. longipes*, *P. ornatus* and *P. penicillatus*. A total of five samples, one from each species, were collected, which were morphologically identified using external appearance and colour patterns, and were analysed using DNA barcoding techniques, targeting the mitochondrial cytochrome oxidase I (COI) gene marker. GenBank accession numbers obtained for the sequenced samples are [PV362736](#), PV362740, PV362762 and PV449455 for *P. versicolor*, *P. penicillatus*, *P. homarus* and *P. longipes*, respectively. The phylogenetic tree constructed with these sequences using the maximum likelihood method showed four clades in the phylogenetic tree. The first clade grouped the *P. homarus* samples from India and Sri Lanka, and the branch lengths indicated a genetic distance of 0.05, consistent with moderate divergence between the two populations. Clustering of Indian and Sri Lankan samples suggests shared evolutionary histories or gene flow between these regions. The second clade included *P. versicolor* samples from Sri Lanka, Indonesia, Australia and Iran. The grouping of geographically dispersed populations highlights the widespread distribution of this species and its genetic connectivity across regions. Sri Lankan *P. versicolor* samples clustered closely with Indonesian sequences, suggesting potential shared ancestry or recent dispersal events. The third clade comprised *P. longipes* samples from Sri Lanka, Australia and Vietnam, indicating a close genetic relationship among geographically distant populations of this species. Clade four comprised *P. penicillatus* samples from Sri Lanka, Spain, and the USA. This study contributes to global DNA barcoding initiatives with a significant advancement in local molecular taxonomy by providing genetic data on ecologically and economically important spiny lobster species. This information is important for conservation programmes, sustainable fisheries management, and future aquaculture initiatives in Sri Lanka.

Keywords: *Panulirus*, spiny lobster, DNA barcoding, Sri Lanka, fisheries management

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

Occurrence of class I integrons among *Aeromonas* species isolated from municipal tap water in Nuwara Eliya District, Sri Lanka

Y.P. Thuduwege, R.M.P.A. Bandara and S.S.S.de S. Jagoda*

Centre for Aquatic Animal Disease Diagnosis and Research, Department of Veterinary Pathobiology, Faculty of Veterinary Medicine and Animal Science, University of Peradeniya, Sri Lanka

Aeromonas are Gram-negative bacteria commonly found in freshwater. They are emerging waterborne pathogens that cause gastrointestinal and systemic infections and often show multidrug resistance, complicating treatment. Integrons are genetic elements that capture and express gene cassettes, usually encoding antibiotic resistance, and help accumulate resistance genes. Class I integrons are the most clinically important and enable horizontal transfer of multiple resistance genes. The objective of this study was to detect the occurrence of class I Integrons and associated gene cassettes of *Aeromonas* isolated from municipal tap water in Nuwara Eliya District. Between December 2024 and May 2025, 38 treated municipal tap water samples were aseptically collected from small-scale restaurants located in the Nuwara Eliya District, Sri Lanka. Samples were processed within 24 hours of collection. Each sample was centrifuged, enriched, and cultured on Glutamate Starch Phenol Red agar. Characteristic colonies of *Aeromonas* were phenotypically characterised through Gram staining and a series of standard biochemical assays. Genetic confirmation at the genus level was carried out by PCR with *Aeromonas* genus-specific primers targeting the 16S rRNA gene. The presence of integrons, their class, and associated resistance gene cassettes was also determined by PCR. Fourteen isolates were initially identified as *Aeromonas* through phenotypic profiling, but only 13 were confirmed by PCR. Eight of the 38 water samples (21.1%) tested positive for *Aeromonas*. Among the 13 PCR-confirmed isolates, 9 were multidrug-resistant (69.2%), 4 isolates carried integrons (30.8%), and 3 isolates carried both class 1 integrons and gene cassettes (23.1%). Our study provides the first molecular evidence of class 1 integron-carrying *Aeromonas* in treated municipal water in this region, highlighting possible shortcomings in water treatment and the associated public health risks. Further studies focusing on identifying *Aeromonas* isolates at the species level and assessing their antimicrobial resistance are underway, aiming to clarify their pathogenic potential and risk assessments.

Keywords: *Aeromonas*, integrons, gene cassettes, drinking water, public health

*Corresponding author email: samanthika@vet.pdn.ac.lk

Molecular insights into the Dwarf Sperm Whale (*Kogia sima*) reported around Sri Lanka based on the mitochondrial D-loop Region

S. Yatawaka , U.S.P.K. Liyanage and D.R. Herath*

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

Marine mammals play an essential role in the marine ecosystem, influencing ecological processes through trophic interactions and nutrient cycling. The dwarf sperm whale (*Kogia sima*) is an elusive cetacean, difficult to observe in the wild, but information can often be gained from stranded individuals and eDNA methods. *K. sima* occurs in temperate and tropical oceans worldwide, usually in deep offshore waters. In Sri Lanka, strandings were documented in Trincomalee (2017) and Panadura (2017, 2022). The mitochondrial D-loop region of these specimens was amplified with the primers M13-Dlp1.5-L and Dlp5-H. The three Sri Lankan sequences were compared with 12 other *K. sima* sequences obtained from the NCBI database. High genetic variability was observed, with 265 polymorphic sites, a haplotype diversity (Hd) of 0.990, nucleotide diversity (π) of 0.126, and an average of 46.6 pairwise nucleotide differences (k). The neutrality tests showed a slightly negative Tajima's D (-0.18), while both Fu and Li's D* (-2.89, $P < 0.02$) and F* (-3.07, $P < 0.02$) were significantly negative. Phylogenetic analysis (Neighbour-Joining, 1,000 bootstraps) revealed that Sri Lankan sequences did not cluster as a single lineage. Trincomalee and Panadura 2022 grouped with Thailand references in an Indo-Pacific clade, while Panadura 2017 was associated with Japanese sequences, highlighting multiple maternal lineages within Sri Lanka. In contrast, Atlantic samples (Italy, Argentina, Gulf of Mexico) formed a distinct and strongly supported clade showing clear regional structuring. This study shows significant genetic diversity and phylogeographic linkage with populations worldwide, revealing preliminary molecular insights into *K. sima* from Sri Lankan waters. To gain a deeper understanding of population structure, gene flow, and conservation implications, larger-scale sampling throughout the region is necessary. Further data collection and analysis will be beneficial for future studies.

Keywords: D-loop region, *Kogia sima*, molecular identification, dwarf sperm whale, genetic diversity

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

Establishment of a reliable environmental DNA (eDNA) analysis method for monitoring marine ecosystems

D.R. Herath*, S. Yatawaka, H.M.U. Ayeshya, D.G.T. Balawardhana and Y.C. Aluwihare

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

Environmental DNA (eDNA) analysis is fast becoming a tool for the non-invasive monitoring of biodiversity in marine environments. The genetic material in aquatic environments from the sheddings of organisms, from dead cells to faeces of marine organisms, can be detected by this special technique. Detection of organisms can be done without visual observations or physical presence. This study was carried out to establish a method for the monitoring of the biodiversity of marine ecosystems using eDNA analysis. Water samples from fish-holds of six multiday fishing boats were collected and filtered. The filtration was carried out by using portable filter units with 0.45 µm pore size nitrocellulose filter papers. The resultant filter papers were stored in ethanol and transported to the lab. The filter papers were used to extract DNA, and the extracted DNA, after confirming the presence of DNA, was sent for metagenomic amplicon sequencing with FishF1/FishR1 and LCO2198/HCO1490 primer pairs. The Next Generation Sequencing results of a sample taken from one boat revealed the presence of 3 species of fish: *Lutjanus fulvivflamma* (black spot snapper), *Thunnus thynnus* (Atlantic bluefin tuna), and *Astroscopus sexspinosus* (Brazilian stargazer). This shows that though these fish species were not in the catch of the boat, that these fish species would have been present in the high seas from which the other fish had been captured by the boat. The highest percentage of 25.25% of the sequences was shown to be the crab species *Scylla serrata*, and in addition, 2 other species of *Scylla* have been recorded. These may have been recorded from the water collected while the boat was catching fish from the area where these *Scylla* species had migrated for spawning. The sequencing results also revealed 1 squid species, *Sepioteuthis lessoniana* and a large number of microorganisms, including twenty species of bacteria (*Shewanella*, *Pseudomonas*, etc.) and viruses, which could have been present as contaminants in the boat. These results helped to establish the technique of eDNA analysis in biodiversity monitoring of marine environments in the future.

Keywords: eDNA analysis, biodiversity, metagenomic amplicon sequencing, marine environment

*Corresponding author email: deishini.herath@gmail.com

Aquatic Environment and Climate Change

Macrozoobenthic diversity in mangrove, salt marsh and tidal flats in Baththalangunduwa Island, off Kalpitiya, Sri Lanka

S.M.C.S. Samarakoon^{1*} and P.A.S.A. Rathnasri¹

¹*Department of Coastal and Marine Resources Management, Ocean University of Sri Lanka*

Macrobenthic fauna plays a significant role in maintaining and balancing coastal ecosystems. This study investigated the diversity and composition of macrobenthos in three different coastal ecosystems, namely mangrove (8.499642N 79.781196E), salt marsh (8.502538N 79.781664E), and tidal flat (8.505116N 79.780347E) in Baththalangunduwa Island, conducted from 18th August to 16th September 2024. A total of nine samples were collected from randomly selected three sites using a 10m line transect in 5m intervals for both macrobenthos identification and soil texture analysis using a 15 cm long soil core with a 5cm diameter. Soil samples collected for macrobenthos analysis were preserved with 100ml of formalin and Rose Bengal solution. Macrobenthos were identified using standard keys using a stereomicroscope. Soil texture was determined using the jar test method, which involves the soil triangle. Total species abundance, species richness, Shannon's index, Simpson's index and Jaccard's similarity index (JSI) were calculated. During the study, a total of 39 species were recorded, belonging to 21 families and 03 phyla. The total macrobenthos abundance recorded in mangrove, salt marsh and tidal flats was 240.41×10^3 , 29.41×10^3 , and 100.69×10^3 (individuals/m³), respectively. The highest species richness was recorded in the mangrove ecosystem, with 26 species, followed by the tidal flat and salt marsh ecosystems, which had 10 and 9 species, respectively. The mangrove ecosystem has the highest diversity (Shannon- 1.5731, Simpson – 0.6096). Shannon's Evenness was highest in the salt marsh ecosystem (0.6578), and Simpson's Evenness were highest in the tidal flat (0.1998). According to the JSI, mangrove and tidal flat ecosystems have more similarity (0.14). *Tellina sp.* (Bivalvia) was common in all three ecosystems. *Cerithium coralium* (gastropoda) has the highest abundance in the mangrove ecosystem, while “unidentified polychaete species 1” and Nereididae (polychaeta) have the highest abundance in salt marshes and tidal flats, respectively. According to one way ANOVA test, the abundance of macrobenthos is significantly different ($P < 0.05$), and the mangrove ecosystem shows the highest mean $\pm$ SD abundance as 70.7 ± 26.70 (individual/m³) and the lowest in the saltmarsh ecosystem as 8.67 ± 5.69 (individual/m³). The soil texture analysis showed that all three ecosystems consist of loamy sand soil texture [mangrove - (sand-84%, silt-13%, clay-2%), saltmarsh - (sand-86%, silt-11%, clay-3%), tidal flat - (sand-85%, silt-11%, clay-4%)]. These findings highlight the abundance of different macrobenthos in different coastal ecosystems, and how mangrove ecosystem provides a shelter for many organisms and why mangrove ecosystems are recognised as an important conserved marine ecosystem.

Keywords: Biodiversity indices, coastal ecosystems, mangroves, tidal flats, salt marshes and macrobenthos)

*Corresponding author email: SupuniCRM2019043@student.ocu.ac.lk

A case study on community-based afforestation for blue carbon in mangrove ecosystems as a strategy for climate change mitigation

A. P. Saputhanthri* and M. P. Kumara

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

Mangrove ecosystems are vital blue carbon habitats that sequester carbon at rates much higher than those of most terrestrial forests, making them vital for climate change mitigation. This study aims to evaluate the effectiveness of community-based mangrove afforestation in the Rekawa Mangrove Afforestation Project, Sri Lanka, initiated in 2007 as a strategy to enhance blue carbon storage and support local livelihoods. The research investigates variations in carbon stocks across two contrasting sites. Above-ground carbon was estimated using allometric equations, below-ground root carbon was calculated from oven-dried biomass using a 0.39 conversion factor, and soil carbon was quantified through stratified soil core sampling and the Loss on Ignition (LOI) method. Above-ground carbon showed no significant difference between sites (Site 1: 10.01 ± 7.05 Mg C/ha; Site 2: 6.29 ± 3.51 Mg C/ha; Mann-Whitney U Test; $p > 0.05$), indicating that plot-level factors, such as tree density, influenced above-ground carbon more than site location. Conversely, soil carbon stock was significantly higher at Site 2 (102.72 ± 25.64 Mg C/ha) than at Site 1 (40.48 ± 19.10 Mg C/ha; two-sample t-test; $p < 0.05$), and differed significantly among soil layers (two-way ANOVA; $p < 0.05$), which was likely due to reduced tidal disturbance. Below-ground root carbon was also significantly higher at Site 2 (0.29 ± 0.05 Mg C/ha) than at Site 1 (0.16 ± 0.02 Mg C/ha; two-sample t-test; $p < 0.05$). Community engagement, assessed through surveys ($n=156$), revealed that scenic value ($\beta = 0.368$), livelihood ($\beta = 0.316$), and economic dependency ($\beta = 0.145$) (multiple regression; $p < 0.05$) significantly influenced willingness to participate in afforestation. The study highlights the potential of community-based afforestation for climate mitigation and recommends enhancing local capacity, integrating financial incentives like Payment for Ecosystem Services, and diversifying mangrove species to optimise carbon sequestration and ensure long-term sustainability.

Keywords: afforestation, blue carbon, mangroves, community-based management

*Corresponding author email: pramodyasaputhanthri@gmail.com

Ecological and fisheries assessment of coastal habitats from Pallikuda to Devil's Point, Sri Lanka: Implications for sea cucumber fattening farm development

M.P. Hendawitharana^{*1}, L.D. Gayathri^{1,2}, K.R. Dalpathadu¹, G.K.A.W. Fernando¹, M.M.C. Karunarathna³, and R.P.P.K. Jayasinghe¹

¹*Marine Biological Resources Division (MBRD), National Aquatic Resources Research and Development Agency (NARA), Crow Island, Colombo 15, Sri Lanka.*

²*University of Bremen, Bibliothekstraße 1, 28359 Bremen, Germany.*

³*IUCN Sri Lanka, 713, D.P. Wijesinghe Mawatha, Pelawatta, Battaramulla, Sri Lanka*

The coastal stretch of ~16km from Pallikuda to Devil's Point in northern Sri Lanka is a biologically diverse and economically significant seascape, integrating coral reefs, seagrass meadows, ichthyoplankton populations, and artisanal fisheries. This study assessed ecological baselines and fisheries patterns to evaluate the feasibility of establishing new sea cucumber fattening farms in the area. Rapid appraisal surveys were conducted in February 2023 during the Northeast monsoon. Ichthyoplankton diversity was assessed at 11 stations across the proposed sea cucumber fattening farm areas using plankton net tows, while benthic communities were characterised through randomised Line Intercept Transects (for coral taxa) and the roaming diver technique (for fish taxa). Fisheries aspects were documented via landing site monitoring, onboard surveys, and fisher interviews. Results confirmed the ecological sensitivity of the area. A total of 68 larvae and 158 fish eggs were recorded, alongside crab zoea, squid paralarvae, and gastropod veligers, indicating that these waters serve as critical breeding and nursery grounds. Coral assessments revealed nine genera, dominated by six sediment-tolerant groups (*Favia*, *Favites*, *Platygyra*, *Leptastrea*, *Turbinaria*, *Porites*), with sponges and nudibranch species contributing to benthic diversity. The study documented 41 reef fish species from 22 families, with seagrass meadows (30-55% cover) functioning as essential habitat for juveniles. In total, 33 economically important fish species from 25 families were recorded, representing pelagic, demersal, and semi-demersal assemblages. Among them, juvenile stages of *Neotrygon kuhlii* and *Epinephelus coioides* were also recorded. In addition, several indicator species were recorded, highlighting the ecological significance of the study area. Evidence from the literature indicates that sea cucumber fattening operations can alter sediment dynamics, reduce organic matter, and contribute to the degradation of benthic habitats. Proposed fencing across 484 ha would impede hydrodynamics and faunal migrations, while nursery ground degradation threatens recruitment in key fisheries (e.g., groupers, squids, mud crabs). These findings strongly discourage establishing sea cucumber farms in this ecologically sensitive spawning and nursery area. Conservation of habitats, sustainable fisheries management, and long-term monitoring are recommended to safeguard biodiversity, productivity, and community livelihoods.

Keywords: Sea Cucumber Fattening Farms, sensitive habitats, ichthyoplankton, coral reefs, habitat degradation

^{*}Corresponding author email: manujarc@gmail.com

Influence of water quality parameters on macroalgal community structure on a tropical rocky reef in Beruwala, Sri Lanka

A. R. K. M. Adhikari^{1*}, E. M. D. Lakmal¹, P.A.Y.A.S. Perera¹, S. K. M. Uddeepana¹, Shamali Rathnasri¹, and K. M. I. D. Karunarathne²

¹ *Department of Coastal and Marine Resource Management, Faculty of Engineering and Management, Ocean University of Sri Lanka, Colombo 15, Sri Lanka*

²*Department of Aquatic Bioresources, Faculty of Urban and Aquatic Bioresources, University of Sri Jayewardenepura, Gangodawila, Nugegoda, Sri Lanka*

Marine macroalgae are multicellular, key primary producers in tropical rocky shores. While Sri Lanka's monsoonal effects on algae are recognised, local water-quality influences remain less studied. This study investigated how horizontal water-quality gradients along Beruwala reef influence macroalgal coverage and composition. Sampling across five reef sites was conducted during January-March 2025 and April-July 2025, periods selected to encompass the Northeast and Southwest monsoons, respectively. At each site, six 10 m transects were established perpendicularly to the shoreline with six 1×1 m quadrats at either side, 0, 5, 10 m distances along the transect and macroalgal composition (Chlorophyceae, Phaeophyceae, Rhodophyceae) and coverage were determined. Water samples (n = 60) were collected at the beginning of each transect and measured at 0.5 m depth using BEP-M900P multiparameter (temperature, salinity, DO, TDS), Hanna HI97728 (Nitrate) and HI97706 (Phosphate) spectrophotometers. Mean (±SD) physicochemical parameters during Northeast and Southwest monsoons were, respectively: salinity 32.68 ± 0.87 and 32.89 ± 0.90 ppt; nitrate 1.76 ± 0.83 and 1.82 ± 0.67 mg L⁻¹; phosphate 0.121 ± 0.06 and 0.128 ± 0.06 mg L⁻¹; and dissolved oxygen 6.71 ± 0.37 and 6.90 ± 0.26 mg L⁻¹. Pearson correlation coefficient revealed that salinity reduced Chlorophyceae cover ($r = -0.173$), markedly reduced Rhodophyceae cover ($r = -0.365$), while Phaeophyceae cover showed a slight positive relationship ($r = +0.053$). DO correlated negatively with Chlorophyceae ($r = -0.334$) but positively with Phaeophyceae ($r = +0.478$) and Rhodophyceae cover ($r = +0.262$). Nitrate revealed weak negative associations with Chlorophyceae ($r = -0.235$) and Rhodophyceae ($r = -0.210$), a weak positive association with Phaeophyceae ($r = +0.190$). Phosphate showed minimal correlations with overall community distribution. (Chlorophyceae $r = +0.105$; Phaeophyceae $r = +0.057$; Rhodophyceae $r = -0.251$). The study indicates factors like turbidity, light penetration, hydrodynamics, and substratum also influence macroalgae, highlighting the need for further research.

Keywords: Marine macroalgae, Monsoonal variation, Rocky reef, Water quality parameters

*Corresponding author email: kavindhyaadhikari2001@gmail.com

Investigation of bioactive properties of mangrove, *Xylocarpus granatum* bark extract from the Sri Lankan coastal area

S.K. Beligammana, S.H.P. Silva, N.M.G.R. Hansima, and H.P.S. Jayapala*

Department of Coastal and Marine Resources Management, Faculty of Engineering and Management, Ocean University of Sri Lanka

Mangrove ecosystems are biologically diverse and pharmacologically significant. Among them, *Xylocarpus granatum* has gained attention for its diverse secondary metabolites and therapeutic potential, particularly in antioxidant and disease-preventive applications. This study aimed to investigate the bioactive properties of *X. granatum* bark with special reference to antioxidant capacity. Antioxidant capacity was quantified using DPPH radical scavenging assay with IC₅₀ determination, Folin-Ciocalteu method for total phenolic content, and aluminium chloride colourimetry for total flavonoid content. *X. granatum* bark was collected from Negombo lagoon, Sri Lanka. The shade dried sample is extracted with methanol. The crude extract, characterised by a dark reddish-brown colour rich in tannins, contained a variety of secondary metabolites such as phenolics, flavonoids, alkaloids, limonoids, and saponins, which are known for their medicinal properties. The crude extract of *X. granatum* was used to evaluate its antioxidant properties. Quantitative antioxidant evaluation using the DPPH radical scavenging assay demonstrated strong dose-dependent activity, showing 80.97% scavenging activity at 200 µg/mL. The extract exhibited a significantly lower IC₅₀ value of 22.93 µg/mL compared to gallic acid (76.46 µg/mL), indicating superior antioxidant potency. Total phenolic content (TPC) analysis quantified approximately 77.86 mg gallic acid equivalents (GAE) per gram of dry extract, underscoring a rich reservoir of phenolic compounds. Similarly, total flavonoid content (TFC) was high, averaging 77.92 mg rutin equivalents (RE) per gram of dry extract, confirming flavonoids as significant contributors to the antioxidant potential. These findings collectively demonstrate that the methanol extract of *X. granatum* bark from Sri Lankan mangroves is a potent source of bioactive phytochemicals with marked antioxidant properties. The study represents the first report on the antioxidant potential of *X. granatum* bark extract from Sri Lankan mangroves. The robust presence of phenolics, flavonoids, and other secondary metabolites supports its traditional medicinal uses and highlights its potential for the development of natural antioxidant-based therapeutics and nutraceuticals. Future studies should focus on isolating and characterising the active compounds and exploring their pharmacological properties for potential therapeutic applications.

Keywords: Antioxidant activity, DPPH assay, IC₅₀, total flavonoid content, total phenolic content, *Xylocarpus granatum*

*Corresponding author email: sajeejayapala@gmail.com

Preliminary assessment of heavy metals and key physicochemical parameters in lagoon water, Chilaw, Sri Lanka

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

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

Chilaw Lagoon, situated on Sri Lanka's western coast, is an ecologically significant estuarine system supporting fisheries, aquaculture, and marine biodiversity. However, increasing anthropogenic inputs from shrimp farming, fish cages, urban runoff, and domestic waste threaten its water quality and overall ecological integrity. This study presents a preliminary assessment of heavy metal contamination and key physicochemical parameters in surface waters of the lagoon over a four-month period (July-October) in 2024. Eleven sampling sites representing aquaculture areas, mangroves, discharge points, and the lagoon mouth were sampled every month. Concentrations of arsenic (As), cadmium (Cd), lead (Pb), and mercury (Hg) were analysed using ICP-MS according to APHA 3125 B methods, alongside measurements of water temperature, pH, dissolved oxygen (DO), nitrate-nitrogen ($\text{NO}_3\text{-N}$), and ammoniacal-nitrogen ($\text{NH}_4\text{-N}$). Arsenic was the most frequently detected heavy metal, with concentrations ranging from 0.001 to 0.003 mg/L. Elevated Arsenic levels were observed in September, particularly near aquaculture and waste discharge sites, indicating potential anthropogenic enrichment. Mercury was detected in August at trace levels (≤ 0.0005 mg/L). Cadmium and lead remained below their respective limits of detection (0.001 mg/L and 0.01 mg/L) throughout the study, suggesting negligible Cd contamination. All measured concentrations were below international guideline values, such as the WHO drinking water guideline and the US EPA guideline for surface waters. Basic water quality parameters exhibited acceptable ecological ranges as temperature varied from 27.2 to 33.9 °C, pH ranged between 7.27 to 8.11, while DO showed 5.3 to 7.8 mg/L, ensuring suitable water quality conditions for sustaining aquatic life. Nutrient concentrations showed localised enrichment, with $\text{NO}_3\text{-N}$ ranging from 0.0104 to 0.0278 mg/L and $\text{NH}_4\text{-N}$ from 0.0041 to 0.0938 mg/L, particularly in the aquaculture-influenced areas. Overall, the water of the Chilaw Lagoon showed low levels of heavy metal contamination. Nevertheless, the presence of arsenic at multiple sites and isolated mercury detections, possibly from feed inputs or antifouling residues, highlights the importance of continuous surveillance and targeted management to prevent degradation of this ecologically and economically vital coastal ecosystem.

Keywords: Chilaw Lagoon, Heavy metals, Water quality

*Corresponding author email: chanarangoda@yahoo.com

Seaweeds foliar sprayer use for organic fertiliser and its effect on the growth of commercial crops in Sri Lanka

J.S. Jayanatha^{1*}, K.W.A.K.M.S. Kumari¹, M.R.M.N Amarasiri², and W.A.L. Wickramasinghe¹

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

²Department of Coastal and Marine Resource Management, Ocean University of Sri Lanka, Colombo 15, Sri Lanka.

Marine seaweeds are valuable sources for producing organic fertilisers that can reduce dependency on chemical inputs in Sri Lanka. This study evaluated the potential of *Sargassum* sp. and *Ulva* sp. as foliar fertilisers to enhance crop growth and yield. Samples were collected from Weligama to Koggala along the southern coast, rinsed with seawater to remove epiphytes and debris, and thoroughly washed with tap and distilled water to eliminate salt. The samples were dried to 15% moisture, powdered, and mixed with distilled water (150 g/L) for four days to extract nutrients. The filtrate was used as a concentrated foliar spray. A pot experiment was conducted using *Capsicum* sp. (MI 2) with three plants per pot under six treatments (T₁-T₆) and four replicates: T₁ (control), T₂ (chemical fertiliser), T₃ (*Sargassum* + fertiliser), T₄ (*Sargassum* only), T₅ (*Ulva* + fertiliser), and T₆ (*Ulva* only). Plant growth and yield data were recorded over 45 days and analysed using ANOVA under a randomised block design, with significance at $p < 0.05$. The highest mean yield was observed in T₅ (101.5 g), followed by T₃, while the lowest was in T₄ (18.75 g). Pod length was greatest in T₃ (5.54 cm) and T₂ (5.52 cm), and lowest in T₆ (5.09 cm). Total yield was highest in T₅ (1616.18 g) and T₃ (1575.75 g). Mean fruit weight peaked in T₃ (73.77 g) and T₅ (69.75 g) and was lowest in T₄ (27.39 g). The results indicate that *Sargassum crassifolium* and *Ulva fasciata* extracts, particularly when combined with fertiliser, significantly enhance plant growth and yield compared to control and single treatments. The post hoc Tukey HSD tests confirmed significant differences among treatments. Mean yield of T₁ (control) differed significantly from T₃ (*Sargassum* + fertiliser) and T₅ (*Ulva* + fertiliser). T₂ (fertiliser) differed from T₄ (*Sargassum* only), and T₃ differed from T₄ and T₆ (*Ulva* only). Significant differences were also found between T₄ and T₅, and between T₅ and T₆ ($p < 0.05$). These findings demonstrate a synergistic effect between seaweed extracts and conventional fertilisers, highlighting the potential of locally available seaweeds as organic fertiliser sources. Their use can reduce synthetic fertiliser dependency, improve soil health, and promote sustainable agriculture in Sri Lanka.

Keywords: seaweeds, organic fertiliser, *Sargassum* sp, foliar sprayer, micronutrients

Corresponding author email: sarathjayanatha1978@gmail.com

Antioxidant properties of crude fucoidan derived from selected seaweed species collected from the Sri Lankan coast

D.K.I.D. Pathirathna^{*1}, S. Gallage¹, S. Jayakody¹, C.V.L. Jayasinghe², and R.G.S. Wijesekara¹

¹*Department of Aquaculture and Fisheries, Faculty of Livestock, Fisheries and Nutrition, Wayamba University of Sri Lanka, Makandura, Gonawila NWP, Sri Lanka*

²*Department of Food Science and Technology, Faculty of Livestock, Fisheries and Nutrition, Wayamba University of Sri Lanka, Makandura, Gonawila NWP, Sri Lanka*

Fucoidan, a sulphated polysaccharide found in the cell walls of brown seaweeds, possesses bioactive properties, including antioxidant activity. This study focused on the extraction, characterisation, and antioxidant capacity assessment of fucoidan from *Sargassum polycystum*, *Gracilaria corticata*, *Acanthophora spicifera*, and *Kappaphycus alvarezii* collected from the Sri Lankan western coast. Fucoidan was extracted using a conventional method involving blending, heating and extraction with 96% ethanol, followed by freeze-drying. Structural characterisation was conducted using FTIR spectroscopy. Antioxidant properties were assessed using the Ferric Reducing Antioxidant Power (FRAP) assay with Trolox as the standard. Additionally, UV absorption (100-400 nm) was measured to evaluate the UV-protective potential of the extracted fucoidan. FTIR spectroscopy confirmed the presence of key functional groups such as hydroxyl, carbonyl, sulfate, and ether groups in fucoidan extracted from four seaweed species. The characteristic peaks verified the sulfated polysaccharide structure of fucoidan. One-way ANOVA followed by Tukey's post-hoc test revealed significant differences ($p < 0.05$) in fucoidan yield and antioxidant activity among species. *S. polycystum* exhibited the highest yield ($1.35 \pm 0.43\%$), significantly different from the others, while *G. corticata* ($0.43 \pm 0.43\%$) and *A. spicifera* ($0.44 \pm 0.43\%$) did not differ significantly. The antioxidant capacity also varied significantly ($p < 0.05$), with *S. polycystum* showing the highest value (29.62 ± 0.23 mg Trolox/g), followed by *K. alvarezii* (3.14 ± 0.01 mg/g), *A. spicifera* (1.22 ± 0.02 mg/g), and *G. corticata* (0.52 ± 0.04 mg/g). UV absorbance analysis (100-400 nm) revealed that *S. polycystum* had the strongest absorbance in UVA (315-400 nm) and UVB (280-315 nm) regions, while the others showed moderate absorbance. These results indicate that fucoidan from *S. polycystum* possesses superior biochemical and photoprotective properties, highlighting its potential application as a natural antioxidant, UV-protective, and bioactive compound for nutraceutical and cosmetic industries.

Keywords: Antioxidant properties, Fucoidan, FTIR spectroscopy, FRAP assay, Seaweed, UV absorption

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*Corresponding author email: darshikaishini@gmail.com

Oceanography, Hydrography and GIS

An automated approach to study the geomorphological changes in the Northwest Coast of Sri Lanka using GIS and remote sensing

E.D. Iroshani Kumari^{1*} and Jagath Gunatilake²

¹*Postgraduate Institute of Science, University of Peradeniya, Peradeniya, Sri Lanka*

²*Department of Geology, University of Peradeniya, Sri Lanka*

This investigates geomorphological changes along Sri Lanka's Northwest coast from Mullikulam to Kondachchil, employing a multidisciplinary approach integrating Geographic Information Systems (GIS), Remote Sensing (RS), and the Digital Shoreline Analysis System. Historical high-resolution satellite imagery, drone, LiDAR, and bathymetric datasets were analysed to assess coastal dynamics across twelve subsections (A-L). The Linear Regression Rate (LRR) and End Point Rate (EPR) models quantified erosion and accretion patterns, revealing a predominantly erosional coastline. Results indicate an average erosion rate of 0.66 m/year (LRR) and 0.62 m/year (EPR), with 90.52% (LRR) and 87.21% (EPR) of transects showing erosion. Statistically significant erosion was observed in 54.20% (LRR) and 78.48% (EPR) of transects, with peak erosion rates reaching 5.35 m/year (LRR) and 5.69 m/year (EPR). Subsection C emerged as an exception, exhibiting localised accretion due to natural breakwater structures mitigating wave energy. In contrast, other zones faced severe erosion driven by sediment deficits and longshore transport toward the Indian Ocean. For comparative analysis, the Southeast coast (Kalmunai to Oluvil) was examined, revealing higher erosion rates (maximum 7.91 m/year) and 83.72% erosional transects under LRR, linked to anthropogenic activities near harbours and natural stressors. Both regions exhibited site-specific drivers: the Northwest coast's sediment dynamics were influenced by natural barriers and transport processes, while the Southeast coast's erosion correlated with human interventions such as harbour construction and reduced sediment replenishment. GIS-based projections forecast shoreline positions for 2024–2044, highlighting urgent risks to infrastructure, ecosystems, and communities. The study underscores the necessity for zone-specific management strategies, emphasising the protection of natural features like breakwaters in Subsection C and addressing sediment loss through improved coastal engineering and policy frameworks. These findings provide critical insights for sustainable coastal management in Sri Lanka, advocating for adaptive measures that balance ecological preservation with developmental needs. By integrating geomorphological insights with predictive modelling, this research offers a replicable framework for coastal vulnerability assessments in monsoon-influenced tropical regions.

Keywords: Coastal erosion, Coastal acceleration, Northwest Coast, GIS

Corresponding author email: iroshani0520@gmail.com

Monsoon-driven variability of surface winds and precipitation in Southern Sri Lanka: A four-year observational case study

L.A.M.H.S. Ruwandika^{1*} and K.W. Indika²

¹*Department of Fisheries and Ocean Sciences, Ocean University of Sri Lanka, Tangalle, Sri Lanka*

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

Sri Lanka is situated within the equatorial Indian Ocean, and it is heavily influenced by monsoon circulation, which governs the spatial and temporal variability of precipitation and wind regimes. This study aims to examine the coupled dynamics of surface coastline using a four-year observational analysis (2020-2023), thereby improving the understanding of regional hydroclimatic processes along the Southern Coast of Sri Lanka. The wind and rainfall data were collected from the Meteorological and Hydrological Station at the Mirissa Fisheries Harbour, established by NARA, and validated using NASA's MERRA-2 reanalysis dataset, which integrates satellite and in-situ observations. The statistical analysis consisted of the normality test, followed by Pearson correlation, and concluded with a regression analysis. The analysis reveals that the Southwest Monsoon (mid-May to mid-September) is dominated by persistent, high-intensity south-westerly winds, frequently exceeding 8 m s^{-1} , whereas the inter-monsoon periods display weaker and more variable wind conditions, with mean speeds typically ranging from $1\text{-}3 \text{ m s}^{-1}$. Daily precipitation exhibits a strong positive correlation with wind speed ($r = 0.910$), indicating strong monsoon-precipitation coupling. In addition, consistent diurnal wind oscillations observed across all years reflect atmospheric coastal circulations (sea-breeze and land-breeze systems) along the southern coast of Sri Lanka. Wind climatology was characterised using the Weibull probability distribution, yielding a scale parameter (λ) of 4.28 m s^{-1} and a shape parameter (k) of 2.4. The mean annual wind speed was 4.97 m s^{-1} , corresponding to a wind power density of 75.19 W m^{-2} , indicative of moderate renewable energy potential but below optimal levels for commercial wind turbines. Precipitation analysis at Mirissa revealed a mean annual rainfall of approximately 1,820 mm, with the highest amounts occurring during the Southwest Monsoon. The monsoon onset dates were identified based on sudden changes in wind speed, wind direction, rainfall, and atmospheric pressure, using in-situ measurements from the Mirissa Meteorology and Hydrological Station (NARA) and validated with NASA's MERRA-2 reanalysis dataset. While the timing of monsoon and inter-monsoon periods is generally consistent each year, inter-annual monsoon variability can cause shifts of up to 1-2 months. The findings provide a detailed characterisation of wind and precipitation patterns along Sri Lanka's southern coast, offering valuable baseline data for improving regional hydroclimatic models, enhancing weather prediction, and informing future assessments of renewable energy potential in coastal areas.

Keywords: Monsoon Variability, Wind climatology, Precipitation patterns, Southern Sri Lanka, Hydroclimatic processes

*Corresponding author email: ruwandikaadhikari@gmail.com

A geospatial analysis of illegal river mining and sand transportation activities associated with the Mahaweli River upper catchment area in Sri Lanka

M.S. Marapana^{1*}, and R.M.K. Ratnayake²

¹Department of Animal Science, Faculty of Animal Science and Export Agriculture, Uva Wellassa University, Badulla, Sri Lanka

²Department of Geography, Faculty of Humanities and Social Sciences, University of Sri Jayewardenepura, Nugegoda, Sri Lanka

Illegal sand mining and transportation activities pose a serious threat to river ecosystems. The Mahaweli River, being the largest river of Sri Lanka, faces this pressure particularly in its upper catchment area. This study analysed the spatiotemporal patterns of the illegal sand mining and transportation activities of the 2019-2024 period to inform targeted management and develop mitigation measures. The data were obtained from police records across 12 Divisional Secretariat Divisions (DSDs), selected based on population density. Raw written data (549 cases) were digitised using Google Maps, Google My Maps, and Google Earth Pro software. Spatial analysis was performed to identify hotspots using ArcMap 10.8, applying Kernel Density Estimation (KDE). The crime data were standardised per 10,000 people to account for variations in population distribution and to ensure that the resulting density patterns represent true crime risk. Temporal trends were examined using Excel software. Median centre analysis assessed shifts in illegal activity distribution over time. Results revealed that illegal sand mining and transportation activities in the upper catchment of the Mahaweli River were unevenly distributed and formed shifting clusters of varying intensity. Peak activity occurred in 2019, with multiple high-intensity hotspots concentrated along the main river channel, extending approximately 8 km along the river corridor in the Mahiyangana area. A notable decline followed in 2020, likely due to COVID-19 lockdown measures, transportation restrictions, and new environmental guidelines by the Geological Survey and Mines Bureau. Although high-density zones largely disappeared in subsequent years, moderate-intensity clusters persisted in localised areas, indicating vulnerability and the need for continuous monitoring and proper management strategies. The study demonstrated the utility of GIS-based approaches for detecting illegal river mining patterns over time and provides evidence-based insights for management activities. Continuous monitoring, strengthened law enforcement, and integration of socio-economic and ecological assessments are recommended to ensure sustainable usage of the Mahaweli River.

Keywords: Mahaweli River, river management, sand mining, spatiotemporal analysis

*Corresponding author email: mayumimarapana@gmail.com

An investigation into the effective design of Floating Photovoltaic (FPV) power plants for inland water bodies: A case study of the Samanalawela Reservoir

K.L.G.A.Jeewantha*, and M.D.E.K.Gunathilaka

Department of Surveying and Geodesy, Faculty of Geomatics, Sabaragamuwa University of Sri Lanka.

Floating photovoltaic (FPV) system integration in inland water bodies is a prospective solution for improving the generation of renewable energy. The objective of this study is to find the best location of an FPV power plant within the Samanalawewa Reservoir, Sri Lanka, by utilising GIS-based fuzzy overlay procedures, with sophisticated hydrographic surveying procedures, to estimate the annual power generation capacity of the proposed FPV system. The main aspects that are taken into consideration are the solar radiation, the proximity to the road, the minimum water surface area, the dam safety zones, and the effects on the environment, as well as the fishing activities. The final suitability map was created using the multi-criteria decision analysis methodology, which was efficient and sustainable. Based on the suitability analysis, the most suitable area identified for FPV installation was 56.3 ha, accounting for approximately 11% of the total reservoir surface area. As previous studies recommend limiting FPV coverage to a maximum of 10% to minimise environmental impacts, only 51 ha from this most suitable zone was selected for the proposed FPV system. The annual power generation capacity was determined by using the energy generation equation, considering the structure design of the PV modules, their efficiency and performance ratio. The 102.7 GWh will be the estimated annual power generation capacity. These findings highlight the significant potential of Floating Photovoltaic technology in supporting Sri Lanka's renewable energy targets.

Keywords: Floating Photovoltaic, Fuzzy overlay, Proximity, Samanalawewa Reservoir, Hydrographic surveying

*Corresponding author email: andrewgayan5@gmail.com

Forecasting sea level variability on the West Coast of Sri Lanka using a Long Short-Term Memory (LSTM) machine learning approach

K.W. Indika*

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

Sea-level observations serve as crucial indicators of climate variability and highlight coastal vulnerability, particularly in the low-lying areas of island states. This study focuses on the LSTM network to forecast sea level, utilising data aggregated from a long-term daily tide gauge record at the Colombo station (March 2006–June 2025). The LSTM model was developed in MATLAB R2018a environment using the Deep Learning Toolbox. The network architecture included an input layer, a single hidden LSTM layer with 100 neurons that output only the final state, and a fully connected regression layer. The network was trained using the Adam optimisation algorithm for 100 epochs, utilising an initial learning rate of 0.001 and a mini-batch size of 20, effectively capturing the temporal dependencies essential for modelling sea level variations.

Model performance was evaluated through a two-step validation process: first, by comparing the reconstructed time series with the observed data, and second, by quantifying statistical error metrics. The model was quantitatively validated using the RMSE, MAE, and NMSE to assess overall prediction error, while the correlation plot provided a direct measure of predicted accuracy. The LSTM model achieved a high Pearson correlation coefficient ($R = 0.782$), indicating a strong positive relationship between the predicted and observed sea level values. The coefficient of determination ($R^2 = 0.482$) demonstrates that 48.6 % of the variability in the observed sea level is explained by model prediction. The predictive accuracy is confirmed by the error metrics, with an RMSE of 50.11 mm and a Mean Absolute Error (MAE) of 40.51 mm. These error values are considered acceptable for long-term forecasting, providing high confidence in the 15-month Prediction. This research highlights the significant potential of machine learning to enhance ocean observation by providing reliable forecasts, strengthening coastal resilience assessments, and facilitating evidence-based policy development for effective coastal resource management.

Keywords: Sea level variability, Sri Lanka, LSTM, Machine Learning, Tide gauge

*Corresponding author email: iweligamage@yahoo.com

Fisheries Socioeconomics and Marketing

Challenges affecting the sustainability of out-growers in the ornamental aquatic plant export sector with special reference to the Western Province of Sri Lanka

V.S. Gunaratne^{*1}, W.M.V.D.B. Kindigoda², H.C.V. Perera², and D.W.L.U. De Silva¹

¹*Socioeconomic and Marketing Research Division, National Aquatic Resources Research and Development Agency (NARA), Crow Island, Colombo 15, Sri Lanka*

²*Department of Coastal and Marine Resources Management, Faculty of Engineering and Management, Ocean University of Sri Lanka, Mattakkuliya, Colombo 15*

This study aimed to identify the challenges that out-growers face in sustaining export-oriented ornamental aquatic plant supply chains. Both primary and secondary data sources were used to gather in-depth insights. A total of 12 out-growers from the Western Province were selected through a simple random sampling technique and interviewed using a pre-tested semi-structured questionnaire. Additionally, in-depth interviews were conducted with four exporters and officials from the National Aquaculture Development Authority (NAQDA) and the Association of Live Tropical Ornamental Fish Exporters of Sri Lanka. The study was conducted from January to July 2024, and data were analysed using SPSS version 22. Results revealed two categories of out-growers: direct export-oriented suppliers and intermediate product suppliers. On average, each facility consisted of four poly tunnels, 1.5 acres of muddy fields, fifteen open ponds, and two net houses, with approximately LKR 3.5 million invested in facility upgrades. Out-growers typically employed four permanent and six occasional workers, most of whom were female, handling around 2,000 pots monthly, with average monthly operational costs of LKR 225,000. The findings highlighted several constraints affecting out-growers. The difficulty in acquiring suitable land for business expansion emerged as the most significant challenge, reported by 9 of the 12 out-growers. This was followed by the high costs associated with upgrading poly tunnels and hydroponic systems (8 of 12), pricing challenges arising from the absence of transparent pricing mechanisms and benchmark prices (8 of 12), and retention of skilled labour (6 of 12). Institutional support was also minimal, with only 5 of the 12 out-growers reporting assistance from extension services. Overall, the findings underscore the need for multidimensional interventions to ensure the continued participation of out-growers in export-oriented ornamental aquatic plant supply chains. Addressing infrastructure, human resources, and financial constraints is essential. Key recommendations include establishing transparent pricing systems with benchmark prices, strengthening exporter grower networks, promoting advanced culture and production methods to enhance industry competitiveness, ensuring compliance with regulatory requirements, and supporting sustainable growth.

Keywords: Barriers, Export-oriented, Ornamental aquatic plants, Out-growers

^{*}Corresponding author email: gunaratnevidura@gmail.com

Evaluating the institutional robustness and co-management arrangements of Rural Fisheries Organisations (RFOs) of selected perennial reservoirs in Ampara District of Sri Lanka

D.W.L.U. De Silva^{*1}, A.M.A.N. Adikari², P.P.M. Heenatigala², V.S. Gunarathne¹ and A.J. Jayathissa²

¹*Socioeconomic and Marketing Research Division, National Aquatic Resources Research and Development Agency (NARA), Crow Island, Colombo 15, Sri Lanka*

²*Inland Aquatic Resource and Aquaculture Division, National Aquatic Resources Research and Development Agency (NARA), Crow Island, Colombo 15, Sri Lanka*

This study aimed to examine the institutional robustness and co-management arrangements of Rural Fisheries Organisations (RFOs) in managing culture-based fisheries (CBFs) in five selected perennial reservoirs in Ampara District, Sri Lanka, with a focus on achieving self-sustaining CBFs. Data were collected through a combination of participatory rural appraisal, key informant interviews, and a semi-structured questionnaire survey conducted using the saturation method from March 2024 to February 2025. Ostrom's modified design principles were applied to assess institutional robustness, while co-management arrangements were evaluated based on Sen and Nielsen's (1996) classification. The findings revealed that the RFOs of Namal Oya, Konduwatuwana, Ekgaloya, and Himidurawa exhibited prominent adherence to seven of Ostrom's principles, with the exception of resource and user monitoring, which was implemented to a moderate degree. In contrast, the Pannalgama RFO showed strong adherence to clear boundary definitions and congruence between rules and local conditions; however, it lacked effective monitoring mechanisms and multi-level institutional structures. Additionally, conflict resolution and the recognition of rights to organise were weak in Pannalgama. High levels of resource user engagement, trustworthy leadership, well-managed revolving funds, regular fingerling release programs, and strong unity and accountability were common features of more robust RFOs, particularly Namal Oya, Konduwatuwana, and Ekgaloya. Weak law enforcement, inadequate monitoring, and unauthorised fishing by non-members were challenges common to all five RFOs, underscoring the need for improved governance and resource security. According to the hierarchy of co-management, Namal Oya, Konduwatuwana, and Ekgaloya were positioned at the "Advisory" level, Himidurawa at the "Cooperative" level, and Pannalgama at the "Consultative" level. Recommendations include providing targeted support to lower-capacity RFOs, focusing on leadership development, financial capacity building, and improved enforcement. Additionally, regular and well-planned fingerling stocking programs, aligned with optimal density levels, are essential for stabilising economic benefits for fishers. The RFOs of Namal Oya, Konduwatuwana, and Ekgaloya are recommended as models for robust and nearly self-sufficient CBF management. Enhanced stakeholder engagement is critical for strengthening the Pannalgama RFO and securing the livelihoods of its members, as this group remains the most vulnerable among the studied reservoirs.

Keywords: Co-management, culture-based fisheries, institutional robustness, perennial reservoirs, rural fisheries organisation

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

Management issues of pole-and-line fishery in Panadura Port and rocks, Kalutara District, Sri Lanka

H.P.D.A. Lakmali*, M.M.A.S. Maheepala, N. Liyanapathirana, V.S. Gunaratne, and P.G.D.M. Anupama

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

Pole-and-line fishing is a long-standing, small-scale fishery in Panadura, Sri Lanka, that has evolved from traditional methods to mechanised operations over the past four decades. Despite its socio-economic importance, the fishery lacks formal regulation, leading to environmental pressures and inter-fishery conflicts. This study was conducted from January to June 2025 and assessed operational practices, socio-economic conditions, and management issues to inform sustainable strategies. The study population consisted of 100 fishermen, and data were collected through field surveys with 30 active fishers, two focus group discussions (n = 28), and direct site observations. Secondary data from government statistics, past studies, and policy documents supplemented the analysis. Quantitative data were analysed using SPSS, while thematic analysis captured qualitative insights. Findings reveal a 70-80 % decline in fish catches over 30-40 years, attributed to near-shore sedimentation from coastal construction, competition with beach seine operations, and restricted fishing access. Most fishers (87 %) now use mechanical pole-and-line machines, targeting Trevally, Barramundi, Barracuda, Red Snapper, Queenfish, and Mackerel Tuna, with average daily earnings of LKR 25,000. However, rising bait costs and limited fishing hours (currently restricted by authorities) reduce profitability. Two local fisher societies, Pole and Line Fishers' Society (Modara) and Shakthi Small-Scale Fishers' Society struggle with official registration, hampering their ability to secure permits and advocate for their rights. Proposed management solutions include: formal registration of fisher societies, extended fishing hours (3 AM-11 PM), stricter regulation or zoning of beach seine operations, habitat restoration via improved water flow (e.g., modifying jetty bunt), and promoting eco-tourism and recreational fishing activity to diversify income. This recommendation aims to restore traditional fishing time without raising fishing pressure, as pole-and-line fishing is low-impact and supported by broader sustainability measures. The study underscores the urgent need for participatory governance and evidence-based management to balance resource conservation with livelihoods. Addressing regulating gear conflicts and strengthening community institutions are critical to sustaining Panadura's pole-and-line fishery and the coastal ecosystem it depends on.

Keywords: Pole and line fishing, fisheries management, socio-economic impacts, Panadura Port and Rocks

*Corresponding author email: achini1218@gmail.com

Analysis of decent work practices and gaps in compliance with international standards among IMUL fishers in Sri Lanka

M.T.N. Thilakarathna*, H.P.D.A. Lakmali, L.A. Kariyawasam, N. Liyanapathirana, P.G.D.M. Anupama and V.S. Gunaratne

Socio-economic and Marketing Research Division, National Aquatic Resources Research and Development Agency (NARA), Crow Island, Colombo 15, Sri Lanka

The decent work perspective is crucial, and it allows for the analysis of a wide range of labour concerns and secure working conditions in fisheries. This study aimed to identify decent work practices in IMUL fisheries and gaps with the ILO standard while exploring fisher perceptions on decent work and social protection. The questionnaire survey was completed from a total sample of 70 boats, comprising boat owners (27.1%), skippers (51.4%), owner cum skippers (11.4%) and fishers (10%) in the five fisheries districts of Negombo, Batticaloa, Puttalam, Jaffna and Matara using the convenience sampling technique. In addition, five awareness programmes were conducted to educate fishermen on decent work in fisheries after completion of the survey. This study employed the ILO decent work framework as its methodological approach. This study gathered both quantitative and qualitative data and focused on key dimensions of decent work, including employment conditions, adequate earnings, decent working time, family and personal life, work that should be abolished, safe work environment, social security and social dialogue. Decent work dimensions from the perception of fishers were collected using a Likert Scale measurement. A mixed-methods approach was employed for data analysis using SPSS 22.0 Statistical Package. Study results revealed that the majority (92.9%) of fishermen were not aware of the decent work concept. The study found that no child labour was employed among IMUL fishers. Further, results revealed that fishermen operating IMUL boats in the 41-60 ft category experienced excessive working hours, averaging around 16 hours per day. However, it depends on factors such as the type of fishing gear used, fishing effort, crew size and prevailing climatic conditions. The lowest income for a crew member, Rs 98,000, was reported in the 28-32 ft boat category. The majority of fishers (60%) reported having adequate safety and health measures on board fishing operations; however, fishery officials noted that the vessels should be further improved to meet international safety standards. 14.3% of fishermen have experienced storms and high-intensity rains, while 8.6% of fishers experienced engine failure and overturned the vessel. According to fisher perceptions, 84.3% reported having freedom to express opinions about their work, 81.4% indicated they are not protected in case of unemployment, and 72% reported their family is not protected either by public or private social protection systems. Sri Lanka complies with most elements of C 188, Work in Fishing Convention; however, some gaps remain in its full implementation within the IMUL fisheries sector.

Keywords: decent work, gaps, International Labour Standards, IMUL fisheries, social protection

*Corresponding author email: thanujam592@gmail.com

Socioeconomic status of boat owners and fishermen in multi-day boats: An empirical study from Galle Fishery Harbour, Southern Province, Sri Lanka

M.K.B.K. Silva*, K. Radampola, J.W. Rupasinghe, and K.G.M. Prabhani

Department of Fisheries and Aquaculture, Faculty of Fisheries and Marine Sciences & Technology, University of Ruhuna

The fisheries sector plays a vital role in Sri Lanka's economy, providing both livelihoods and food security. This study examined the socio-economic status of fishers operating multiday boats in Galle Harbour. Primary data covered 10% of the average monthly boat arrivals (n=38 boat arrivals) in 2024. Primary data were collected from randomly selected boat owners, skippers, and crew members by visiting the harbour 3 days per week using questionnaires, focus group discussions, and participant observations, while secondary data were obtained from the Fisheries Office, Galle, in July 2024. Data were analysed using MS Excel 2016 and IBM SPSS 25.0. Results showed that the majority of boat owners were between 40-60 years, while the majority of skippers (56.25%) and crew members (39.36%) were between 30-40 years. Educational qualifications of fishers were mostly up to the GCE O/L level (81.91%) due to their lack of awareness about education, and the majority of households had school-aged children. The majority of boat owners' average monthly income was significantly higher (>5,000,000 SL Rupees) than the average monthly income of skippers (100,000 – 500,000 SL Rupees) and crew members (50,000 - 100,000 SL Rupees). Due to the income variation of fishers' boat owners had more physical assets than fishermen. Most fishers relied on bank loans when needed, but the majority of boat owners had taken loans to buy boats, while the majority of skippers and crew members had taken loans to fulfil day-to-day needs. Fishing was the primary occupation of most fishers. A SWOT analysis highlighted indigenous knowledge, higher fishing experience, and the relatively higher incomes of boat owners as key strengths. Weaknesses included limited awareness of sustainable practices and inadequate facilities. Major opportunities were higher catch potential and the role of local buyers, while threats included immature fish harvests and illegal foreign fishing activities.

Keywords: Socio-economic status, Galle harbour, boat owners, skippers, crew members

*Corresponding author email: kasunibk@gmail.com

Socioeconomic challenges and sustainability issues of the small-scale fishing community in Baththalangunduwa Island, Sri Lanka

S.N. Ranathunge¹, M.C.L. Zoysa^{1*}, S. Rathnasri¹ and A.A.S.H. Athukoorala²

¹*Department of Coastal and Marine Resources Management, Faculty of Engineering and Management, Ocean University of Sri Lanka, Crow Island, Colombo 15*

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

Baththalangunduwa Island, located 38 km off Kalpitiya, is a fishing village that attracts fishermen from various regions of Sri Lanka during the peak fishing season from November to April. However, due to persistent hardships, many of the permanent fishermen are migrating back to the mainland, raising long-term concerns about the sustainability of the fishing profession on the island. This study aimed to investigate the socioeconomic status, challenges and sustainability issues faced by the Baththalangunduwa fishing community. The study used a mixed-method approach. Socioeconomic data were collected through semi-structured field interviews with 50 fishermen, conducted between August and October 2024. Statistical analysis was performed using SPSS v23 software. The Wilcoxon signed-rank test was applied to identify statistically significant challenges related to occupational conditions. Additionally, mean ranks were calculated for Likert scale data to evaluate community challenges. Results indicated that most fishermen are middle-aged (54% aged 34-49), married (78%), and support 3-4 dependents (56%). Educational attainment is mostly low, with 60% having completed only primary schooling, and none having achieved a tertiary education. The community is predominantly Sinhala Catholic (70%), and 65% of the fishermen originally hail from Negombo. Fishing experience is extensive, with 32% of respondents having more than 26 years of experience, and 84% being generational fishermen. However, 94% lack formal training in modern fishing techniques. Income analysis revealed that approximately 70% earn above LKR 100,000 per month, yet 76% lack alternative income sources. Fuel prices, equipment costs, declining fish yields, and unfair market pricing were identified as statistically significant occupational issues. 38% of fishermen reported inadequate protection at sea. The study also revealed community challenges related to infrastructure, including poor access to sanitation, inadequate water supply, and unreliable electricity, which were ranked as the most pressing concerns. Despite these challenges, 86% of the respondents remain committed to fishing, with preferred solutions including increased government support (30%), targeted subsidies (29%), and formal training programs (22%). The findings highlight a resilient fishing community with a strong occupational identity, yet significant structural vulnerabilities, including educational gaps, inadequate safety measures, infrastructure deficits, and economic dependence on fishing. These challenges necessitate comprehensive policy interventions focusing on training, safety improvements, and infrastructure development to ensure the sustainability of the fishing industry and prevent further migration that threatens the stability of generational fishing practices and community cohesion.

Keywords: Coastal livelihoods, Fisheries management, Occupational resilience, Small-scale fisheries, Socioeconomic challenges

*Corresponding author email: chathurikaZ@gmail.com

Potential livelihood impacts of ecosystem changes driven by saltwater incursion in Mawella Lagoon, Hambantota, Sri Lanka

S. Jayanatha^{1,2*}, W. Suwandahannadi¹, M.N. Amarasiri³, and K. Madusha²

¹*National Aquatic Resources Research and Development Agency, Regional Research Centre, Weligama, Sri Lanka.*

²*National Aquatic Resources Research and Development Agency, Regional Research Centre, Rekawa, Sri Lanka.*

³*Ocean University of Sri Lanka, Colombo.*

Mawella is a coastal lagoon located Hambantota district of Sri Lanka. This lagoon provides several livelihood prospects for the people in 12 Grama Niladari (GN) divisions. The lagoon extends approximately 91 ha, but its area is declining gradually, due to encroachment. Seawater incursion, mass fish were reported recent past. Thus, a study was carried out from February to September in 2025 to identify the potential impacts on livelihoods and social ecological systems (SES) of the community. The survey was conducted by interviewing the local communities selected through the snowball sampling method. Demographic data, livelihood details, daily incomes, and changes in livelihood patterns due to ecosystem changes were collected and analysed using the Minitab version 17. The results showed that Mawella lagoon provides several livelihoods, i.e. lagoon fishery, collecting of the lotus flowers and herbaceous stems, and nature-based tourism activities such as bird watching, kayak boat safaris, and boat tours. Lagoon fishery and the collecting of lotus stems and flowers were identified as the key livelihoods contributing to 61.19% and 35.07% respectively. Women were primarily engaged in collecting lotus flowers and stems, whereas males engaged in fishing activities. Before the saltwater intrusion, the daily fish harvest was approximately 10-15 kg, but it has now declined to 3-5 kg. Similarly, the daily income earned from both lagoon fisheries and lotus harvesting, which previously ranged from Rs. 10,000-15,000, has decreased significantly to Rs. 1,500-3,000. The age composition showed that the majority of fishers were in the 40-49 year age group (33.34%), while only 9.52% were within the 20-29 year age group. The majority of fishers were traditional fishers with 20–29 years of fishing experience. The lotus-dependent industry has a relatively short history of 10-15 years, created a new livelihood option for the community. However, a sudden increase in salinity in the lagoon has led to the complete disappearance of lotus, directly affecting on livelihoods of families. The present study highlights a potential socio-economic threat to communities resulting from rapid environmental changes caused by saltwater incursion and associated ecosystem transitions. It is essential to implement adaptive management strategies to minimise the livelihood losses.

Keywords: Saltwater incursion, ecosystem changes, fishers, livelihoods, Mawella lagoon,

*Corresponding author email: sarathjayanatha1978@gmail.com

Efficiency analysis of intensive shrimp farming in the Puttalam District of Sri Lanka

P. S. K. Perera¹, D. Hemachandra¹, D. W. L. U. De Silva² and R. Weerasingha^{2*}

¹*Department of Agricultural Economics and Business Management, Faculty of Agriculture, University of Peradeniya*

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

Shrimp farming remains an important contributor to Sri Lanka's aquaculture sector, yet its growth is constrained by recurring disease outbreaks, environmental degradation and rising production costs. Although the introduction of *Litopenaeus vannamei* in 2019 temporarily improved yields, recent production declines indicate persistent inefficiencies. This study assesses the technical (TE), allocative (AE), and economic efficiency (EE) of intensive shrimp farming in the Puttalam district using data from 60 randomly selected farms across five major production zones. Primary data were collected through structured interviews and field surveys conducted in February 2025. An input-oriented Data Envelopment Analysis (DEA) under constant returns to scale was employed, followed by a Tobit regression to examine determinants of inefficiency. Results show mean TE, AE, and EE scores of 0.806, 0.790, and 0.638, respectively, demonstrating that farms operate at approximately 80% of their productive potential and could reduce input costs by about 21% through more efficient resource use. Only 9% of farms achieved full economic efficiency. Total cultured area was identified as the only statistically significant factor affecting inefficiency, with larger farms exhibiting higher efficiency levels. Descriptive findings reveal that 70% of farms were profitable, while all non-profitable farms experienced disease outbreaks, highlighting the critical influence of biosecurity lapses. Feed cost accounted for 55% of total production cost, underscoring the importance of feed management and FCR optimisation. The study recommends prioritising improved feed practices, strengthened disease management, and adoption of best management practices to enhance both technical and cost efficiency. Policy measures such as reducing taxes on feed ingredients, supporting local feed production, improving post-larvae quality standards, strengthening extension services, and promoting efficient farm-scale expansion are essential for enhancing profitability and long-term sustainability. The findings provide important insights for policymakers and industry stakeholders seeking to improve economic efficiency and resilience within Sri Lanka's shrimp farming sector.

Keywords: Technical efficiency, allocative efficiency, economic efficiency and shrimp farming

*Corresponding author email: rochanaweerasingha@gmail.com

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"A solitary brain coral stands resilient among the patchwork of the shallow reef, its intricate valleys and ridges sculpted by years of growth and shifting currents. Captured at close range in the clear waters of Trincomalee, Sri Lanka. This image reveals the quiet strength and textured beauty of one of the reef's most enduring architects."

IMAGE COURTESY: M. P. HENDAWITHRANA



NATIONAL AQUATIC RESOURCES RESEARCH AND DEVELOPMENT AGENCY,
CROW ISLAND,
MATTAKKULIYA,
COLOMBO 15,
SRI LANKA
www.nara.gov.lk