THE RESEARCH OUTLOOK 2022

Socio-economic and Marketing Research Division
National Aquatic Resources Research and Development Agency (NARA)

ACKNOWLEDGEMENT

The research outlook is the annual publication of Socio-economic and Marketing Research Division of National Aquatic Resources Research and Development Agency (NARA). The first volume of the Research Outlook is published in the year 2022. This publication is encapsulated research and development activities undertaken by different Technical Divisions and Regional Research Centers of NARA during the year 2022. Research findings and outcomes of annual research program of NARA which are highly important in addressing issues and formulating policies related to the respective thrust areas of fisheries and other aquatic resources are included in this publication. Further, information include in this volume are very much helpful for a broad spectrum of users who are interested in the fields of fisheries. I would like to express my sincere gratitude to whom joined hand with me in supporting to complete the task meaningfully and successfully. As the Head of Division and officer in charge in publishing this annual publication, I appreciate valuable comments from users of this volume for the enhancement in coming years. Further, I must acknowledge Dr. Kamal Thennakoon, Director General of NARA who brought forward the idea and continuous support given me to achieve the task successfully.

K. H. M. L. Amaralal,
Principal Scientist of Socio-economic and Market Research
Head Socio-economic and Market Research Division

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ESTABLISHMENT AND MANDATE

National Aquatic Resources Research and Development Agency (NARA) was established in 1981 under the National Aquatic Resources Research Agency Act of Number 54 subsequently amended Act of Number 32 of 1996 under the Ministry of fisheries and aquatic resources development of Sri Lanka. NARA is the premier institution mandated with undertaking research and development activities for the development, conservation, and management of fisheries and aquatic resources of Sri Lanka

VISION

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

MISION

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

KEY FUNCTIONS

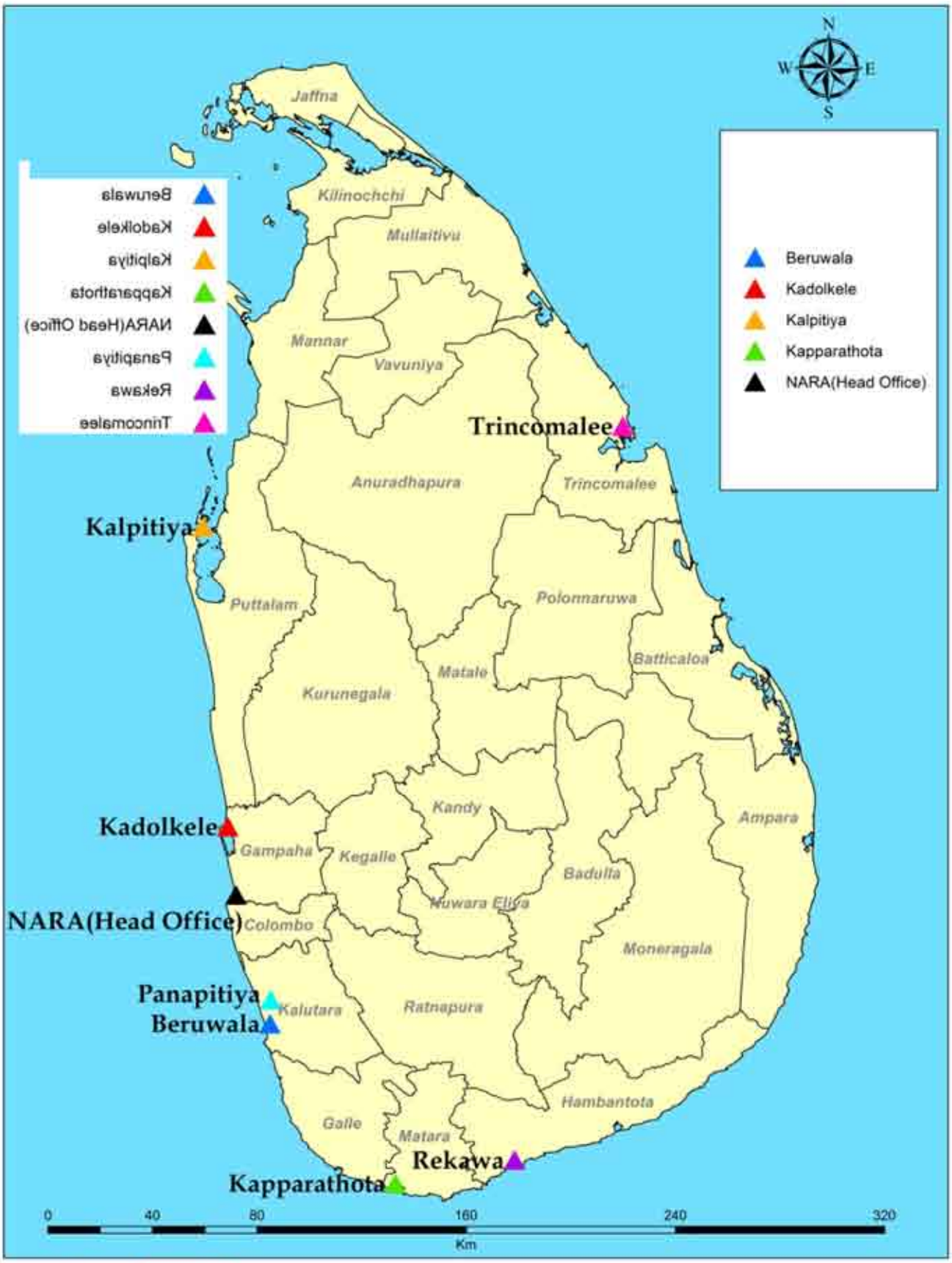
Promote and conduct scientific research, assessment, management, development, and conservation of living and non-living aquatic resources.

Provide advisory, consultancy, and testing services; and policy recommendations on the exploitation, management, development, and conservation of living and non-living aquatic resources.

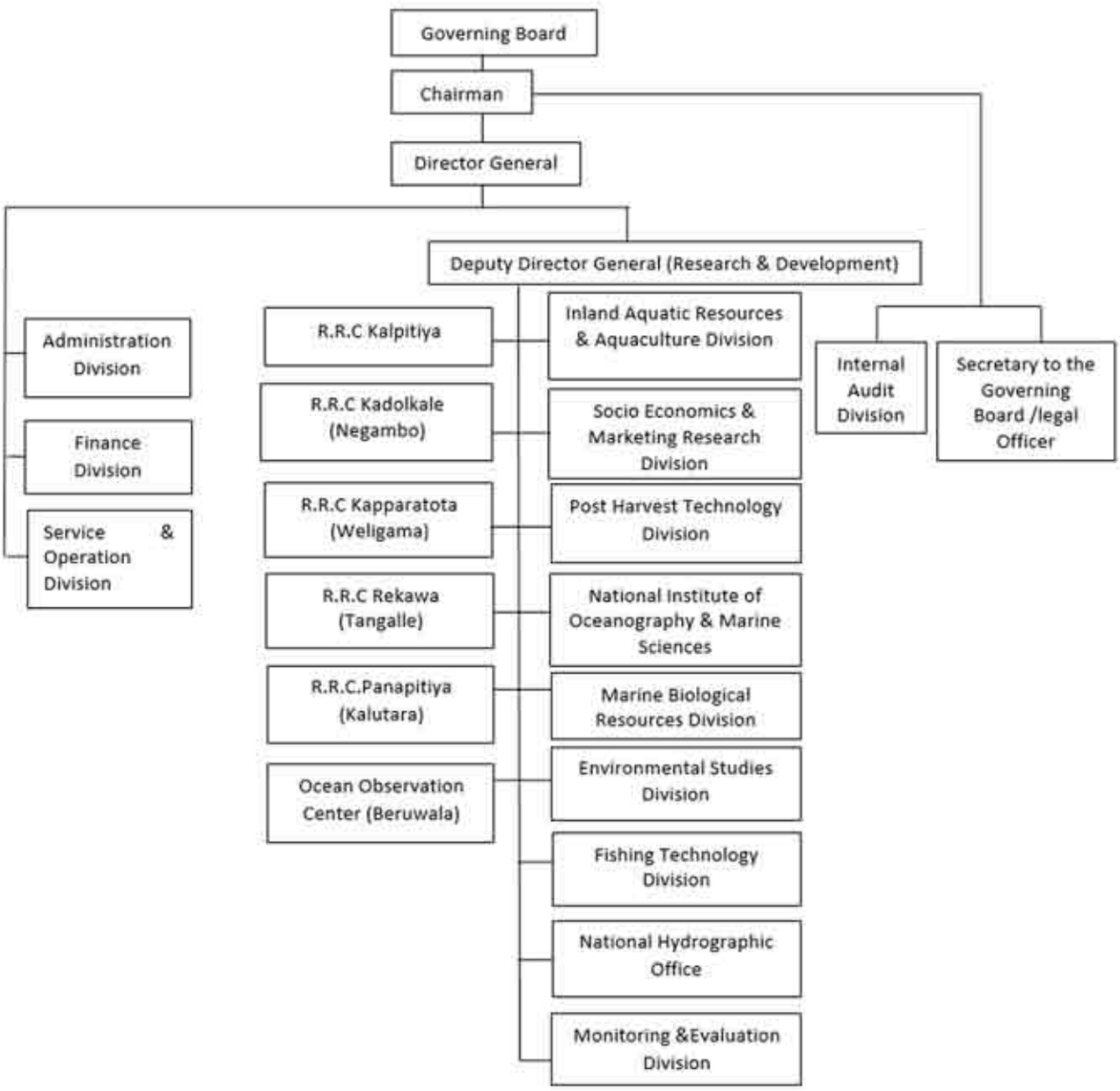
Dissemination and publication of scientific research findings.

Provide training and awareness to stakeholders and the general public

REGIONAL RESEARCH CENTRES (RRCs)



ORGANIZATIONAL STRUCTURE



HUMAN RESOURCES

STAFF CATEGORY	AVAILABILITY
DIRECTORS	04
PRINCIPAL SCIENTIST	10
CHIEF HYDROGRAPHER	01
DEPUTY HYDROGRAPHER	01
SENIOR SCIENTIST	17
SCIENTIST	49
HYDROGRAPHIC SURVEYOR	07
RESEARCH ASSISTANT	33
PROJECT ASSISTANT	01
DEVELOPMENT OFFICER	04
FIELD RESEARCH ASSISTANT	08
OTHER STAFF	179
GRAND TOTAL	314

RESEARCH HIGHLIGHTS
2022

ENVIRONMENTAL STUDIES DIVISION

Water Pollution Assessments in Fishery Harbors

The objective of the study was to assess the current status of water quality and impacts of anthropogenic activities in five selected fishery harbours in Western and Southern provinces of Sri Lanka.

The study found that water quality had degraded due to the severe oil pollution, organic pollution and microbial contamination in terms of fecal contamination. The most polluted harbours were Beruwala and Mirissa and only few parameters relevant to the other three harbours were found beyond the stipulated standard limits prescribed by Central Environmental Authority. Plankton analysis revealed *Tropidoneis sp.* and *Protoperidium* species were found in the water. The main sources of water pollution were discharge of burnt oil and bilge water from fishing vessels, production of loads of organic wastes derived from fish degutting, market floor cleaning runoff, garbage dumping, accidental oil spillage during re-fuelling, solid waste from boat repairing, untreated sewage, and defecation inside the harbor premises.

Investigation of emergency incidents

The investigations deal with environmental emergency incidents such as mass fish kills, oil spills, water pollution from toxic chemicals, sudden algal blooms and water quality deteriorations to determine the magnitude, present and potential impacts while provide mitigation measures. In addition, study outcomes are disseminated to government organizations such as Marine Environment Protection Authority (MEPA), Coastal Conservation Department (CCD), Central Environment Authority (CEA), Environmental Division of Sri Lanka Police, local administrative authorities, MOH Department and other institutions. During an emergency investigations the following tasks are usually carried out; field investigations, laboratory analysis, technical report preparation and conducting technical meetings with relevant parties. During the year, several emergency investigations such as the shipwreck removal and environmental impact monitoring of MV X-press Pearl burning disaster, sea cucumber farming and its implications on fisheries livelihoods in Kiranchi and Parititivu, identification of issues in brush pile fishery in Jaffna District, discoloration of coastal water in Galle Face beach, identification of algal blooms in Beruwala fishery harbor and Southern coast of Sri Lanka and investigation of resources utilization and management of Jaffna trawl fisheries were carried out.

FISHING TECHNOLOGY DIVISION

Feasibility of submerged gill nets and promote pole and line technique for Skipjack Tuna fishery in Sri Lanka

The exploring of potential implementation of IOTC 19/01 to keep drift gill nets submerged at a depth of 2 meters and barriers to pole and line technique in skipjack tuna fishery in Sri Lanka. The study found that the IMUL boats operated on the west and south coasts have adjustable long buoys, making it possible to keep the gill net floating in the open ocean 2 m deep. However, fishers in eastern coast do not use a buoy rope and therefore, unable to meet 2 meter depth. The IOTC resolution can be implemented for the west and south coasts but East coast. It finds short comings in harvesting methods of live bait, access to tuna fishing grounds beyond 10 NM, technology, skills and requirement of valid fishing licenses were major barriers for the expansion of the Pole and Line fishery in Sri Lanka.

INLAND AQUATIC RESOURCES AND AQUACULTURE DIVISION

The Application of Biofloc Technology in Aquaculture

The study aims to evaluate different carbon sources and combinations on fish growth, health, water quality and microbial activities of *Cyprinus rubrofuscus* and *Oreochromis niloticus*. The study finds molasses (MO) based BFT system is more suitable to rear *Cyprinus rubrofuscus* post-larvae compared to other carbon sources and fermented inoculants with *bacillus* sp shows higher performances in biofloc system in *Oreochromis niloticus* advanced fingerling stage.

The Application of Hydroponic Culture Techniques for Aquatic Plants in Aquaponic system

The hydroponic culture techniques were practiced in three ways as the floating raft method (deep water culture technique), Nutrient Film Technique (NFT) and gravel bed system. The study assesses effect of different hydroponic culture techniques for the growth performance of Anubias and Bacopa species in aquaponic system.

The study finds *Anubius* and *Bacopa* plants well performed in all the three systems without any nutrient imbalances. In comparison with 3 systems gravel bed system was backward than others while the NFT performed the best. Further, it suggested vertically cultivation using the NFT which gives the maximum production per unit area.

The Application of In - vitro Propagation Protocols for Aquatic Plant Species

Application of a protocol for the micro-propagation technique for *Aponogeton* and *Nymphaea* species was the main objective of the study. Utilization of different concentrations of plant growth hormones in Murashige and Skoog medium to generate shoots or callus from ex-plant were done. Different concentration of growth hormones for shoot multiplication and rooting stages of *Aponogeton* species also used. The study finds a best protocol for micro propagation of *Aponogeton* species for better growth of the aquatic plant.

Development of an Appropriate Method to Increase Hatching Rate and Larval Survival of Barb Fish *(Barbus conchonius)*

In several breeding trials *Barbus conchonius* eggs were conditioned with several doses of L-ascorbic acid as 0, 250, 500, 750, 1000, 1250 mg/l with three replicates to determine hatching time, hatching rate and larval survival rate. The study finds when barb fish eggs were conditioned with 1000 mg/l L - ascorbic acid the hatching time was reduced to 48hrs but the hatching rate was significantly different between treatments and the best hatching rate (81%) and survival rate (83%) were found when eggs were conditioned with 1000 mg/l L-ascorbic acid.

Development of Induce Breeding Method for Thai Oranda Goldfish *(Carassius auratus)* Using Double Dose of Hormone

The study aims to develop a breeding method for Thai Oranda goldfish (Carassius auratus).Brooders were conditioned with high protein diets until sexually matured. Breeding trials were conducted using double dosses of hormone ovulin as 0.0, 0.5, 0.7 and 1.0 ml/kg for female while single dose for male. The second dose of hormone for female was given after 2h of the first dose and male were injected after 1h the second dose of female and three replicates were done. The study finds fecundity and hatching rate were significantly different among treatments and the best fecundity was found when using double dose of 0.7ml/kg for female while single dose for male as (1016 ± 45). The latency period was 6h and hatching rate was recorded as 83.97%. It is further found Thai Oranda goldfish can be successfully induced for breeding using double dose of 0.7 ml/kg for female and single dose for male.

Disease and Water Quality Monitoring in Shrimp Aquaculture

The monitoring program aims to minimize losses from disease outbreaks by early disease diagnosis through disease monitoring of L. vannamei culture systems. The study finds out of 48 samples tested for viruses 6 % were positive for the WSSV with a detected level of infection as indicated in the system's instruction manual and all of them were from Madurankuliya area but all samples were negative for the IHHNV, AHPND and NHPB. Further, it is identified the level of BMP adopted by different sub-zones for the management of disease.

The Pearl Oyster Culture

The aim of the study was to develop a culture technique and find the suitable locations for pearl oyster culture in East and North coast of Sri Lanka. Further it intends to identify the technique for pearl nucleation with the assistance of pearl research group.

A floating raft system made with woods was introduced but Silawathura area was identified as unsuitable for pearl oyster culture due to the high wave actions during the monsoonal period. The Cod Bay area is identified as a suitable area for pearl oyster culture in East of Sri Lanka.

POST HARVEST TECHNOLOGY DIVISON

Upgrade the laboratory in complying with the revised ISO/IEC 17025:2017 Standard

To align with the revised ISO/IEC 17025:2017 standard, the quality control laboratory has undergone an upgrade. This laboratory is certified under ISO/IEC 17025:2017 for conducting microbiological assessments in water (seawater, coastal water, potable water, freshwater, and ice), as well as fish, shellfish (chilled, frozen, and canned), and dried fish samples. To ensure compliance with the updated standard, the laboratory reviewed the new requirements and made necessary adjustments to its practices and documentation and implement the revised laboratory procedures.

Introduction of a refrigeration system for the multiday fishing boat

In a collaborative effort, the IPHT and the National Engineering Research and Development Center (NERDC) undertook a pilot project to develop a refrigeration system tailored for a multiday fishing boat.

Modernization of Maldives fish and dried fish production lines in Sri Lanka

The objective of the study was to enhance the conventional processing methods used in the Maldive fish and dried fish production. This involved the development of innovative machinery and technological solutions to guarantee the production of a final product that meets high standards of quality and safety. The implementation involved the introduction of various equipment to enhance the temporary storage, cutting, boiling, smoking, and drying processes of fish. These included fiber boxes for temporary fish storage, stainless steel tables for fish cutting, stainless steel vessels and wire baskets for fish boiling, smoking units for fish smoking, and drying tables and dryers for fish drying.

Study of antimicrobial resistance in shrimp culture in North Western Province of Sri Lanka.

The antibiotic susceptibility of 153 E. coli isolates, consisting of 60 isolates from shrimps and 93 isolates from culture pond water, was examined for 12 antibiotics. A significant proportion of the isolates demonstrated resistance to several antibiotics. For instance, Erythromycin resistance was observed in 81.67% of shrimp isolates and 95.7% of water isolates. Similarly, resistance to Gentamycin was prevalent in 45% of shrimp isolates and 45.16% of water isolates. Ampicillin resistance was found in 28.33% of shrimp isolates and 48.39% of water isolates. Tetracycline resistance was identified in 16.67% of shrimp isolates and 22.58% of water isolates. Nalidixic acid resistance was present in 16.67% of shrimp isolates and 12.90% of water isolates. Lastly, Chloramphenicol resistance was observed in only 1.67% of shrimp isolates but in a higher proportion of 13.98% among water isolates.

Evaluation of anti-microbial activity of selected commercial disinfectants used against histamine forming bacteria and spoilage bacteria and effect of storage temperature on bacterial growth and histamine formation in Yellowfin tuna

The study aims to evaluate anti-microbial activity of selected commercial disinfectants used in the fish processing factories and some multiday fishing boats against Klebsiella aerogenes, Morganella morganii and Pseudomonas sp. and evaluation of effect of temperature on histamine formation by Klebsiella aerogenes. Disinfectants used in this study contained triclosan (A), quaternary ammonium compounds (B), hydrogen peroxide (C) and sodium hypochlorite (D) as active agents. Results showed that product A with triclosan indicated a zero inhibition while other three products showed <10 CFU/mL counts for the manufacturer recommended concentrations i.e., A – 5%, B – 0.1%, C – 0.5% and D-5% with a >5 log 10 reduction factor (RF) for disinfectants B, C and D. Comparison of RF of each disinfectant revealed that there is a significant difference ($p<0.05$) between A and other disinfectants (B, C, D). The bacterial counts were increased with the decreasing concentrations of the disinfectant. According to obtained results, commercial disinfectants with quaternary ammonium compounds (20 – 25%), hydrogen peroxide (8 - 35%) and sodium hypochlorite (5-10%) can be recommended to clean fish contacting surfaces to minimize contaminations rather than cleaning with detergents alone.

Growth of K. aerogens (isolated from early stages of this study and known to be a major histamine forming bacteria) and histamine formation in fish at different temperatures was studied and it was evident that at abuse temperatures (15°C) histamine formation by K. aerogens was high. At 2°C histamine formation was controlled.

Trace Metal Analysis on X-press Pearl Ship Burning Incident

In response to the X-PRESS Pearl ship incident, the IPHT has undertaken comprehensive trace metal analyses. This study involves examining fish, seawater, and sediment samples collected from various locations within the affected area along the western coastal belt, spanning from Galle to Kalpitiya. Additionally, non-affected areas such as Trincomalee and Pulmoddai are also included. The trace metal analysis specifically targets elements including Al, Cd, Cu, Cr, Fe, Li, Pb, Hg, Mo, and Zn. A total of 192 fish samples, 30 seawater samples, and 20 sediment samples have been meticulously analyzed. As there is a potential for bioaccumulation of heavy metals in fish, IPHT is carrying out continuous investigations to monitor such accumulation.

MARINE BIOLOGIAL RESOURCES DIVISION

Monitoring and assessment of coastal fisheries

The study aims to collect and analyse catch and effort data, fishery-related parameters and biological data to assess the status of resources and stocks of Big eye scad *(Selar crumenophthalmus)*, Indian mackerel *(Rastrelliger kanagurta)*, and Shorthead anchovy *(Encrasicholina heteroloba)* on the West Coast of Sri Lanka. The CPUE of spotted sardinella *(Amblygaster sirm)* in small meshed gillnet fishery was standardized using port sampling data by applying Delta-log normal approach. The data-poor stock assessment method, the stochastic length-based spawning potential ratio (LBSPR) was used to assess the same stock. The results revealed that the stock of spotted sardinella which was considerably depleted previously is likely recovering mainly due to the low fishing pressure as a result of the COVID-19 and X-press pearl ship disaster in 2021. The fishing effort reduction by controlling the number of boats would be a policy option to restore the fish stocks in short-term and attain sustainability in longer term in coastal fisheries of the country.

Monitoring and assessment of large pelagic fisheries

The study aims to strength the existing large pelagic port sampling to obtain more data through collaborative with Department of Fisheries and Aquatic Resources (DFAR) and Statistics Unit of the Ministry of Fisheries (MoF). The large pelagic port sampling survey was commenced in the 1990's with the objective of collecting catch and effort data and biological data of tuna and tuna-like fish species. Further, it is a mandatory requirement to provide these data for the Indian Ocean Tuna Commission (IOTC) annually before the 30th of June every year. The data should be complied with the resolutions of 15/02 implemented by the IOTC. As a result of complying with the resolutions Sri Lanka was achieved a 76% compliance rate in 2021. The study findings concluded that in overall the potential of expanding of large pelagic fisheries are currently limited due to the present regional level management and conservation measures imposed based on the stock status of the species in the Indian Ocean. However, the expansion potentials could still be pragmatic for skipjack tuna and swordfish fisheries.

Feasibility Assessment of the Pole and Line fishery

The study aims to assess the feasibility of expanding the pole and line fishery for skipjack tuna in Sri Lanka. However, findings revealed that the expansion of the pole and line fishery could only be practical for live bait. Nevertheless, if vessels can be upgraded to reach the free tuna fishing grounds with the required technical skills of fishers the fishery is possible.

Fisheries Independent Surveys

The surveys aim to conduct the Ichthyoplankton and acoustic surveys in selected areas around the country using the RV Samudrika of NARA and trawl surveys at Kalpitiya shrimp trawling ground (~15 km2) using a commercial trawler (90 HP) with a trawl net to estimate shrimp biomass. Totally, twenty-five trawl hauls were conducted at randomly selected stations while applying Swept area method to estimate the density and biomass of shrimps and fish using StoX, software commonly applied for fish biomass estimates of large commercial European fish stocks. Results found that Penaeid shrimps contributed 32% to the total biomass and of seven species of shrimps, *Penaeus semisulcatus* (43%) and *P. merguiensis* (36%) were the most dominant and an exotic species *P. vannamei* was also recorded. Further, the presence of 60% of immature *P. semisulcatus* indicated that there might be a migratory route or spawning grounds in this area while in contrast, the majority of mature individuals were found in *P. indicus* and *P. merguiensis* populations. The fish species Karalla dussumieri and Arius maculatus highly contributed to the by-catch biomasses.

NATIONAL HYDROGRAPHIC OFFICE

Establishment of a Database and online data processing unit for crowd sourced bathymetry

The objective of this study is to gather crowd sourced bathymetry from all the possible means (research vessels, commercial ship cruises, fishing vessels, satellite derived bathymetry etc.), establish a Unit for create a bathymetric database with the metadata information and online data processing and mapping the sea bed, identify the geomorphological features and provide information to utilize the marine applications. This study is parallel with the objectives of the global mapping project "Sea Bed 2030"by GEBCO and the United Nations Decade of Ocean Sciences for Sustainable Development.

NATIONAL INSTITUTE OF OCENOGRAPHY AND MARINE SIENCES

Information on Tuna Fishing Groundsand Advisory Service

The prime objective of the service is to provide information on potential tuna fishing ground advisories for Multiday fishers. The system uses sea surface temperature, sea surface height and sea surface chlorophyll data obtained from satellite remote sensing, fisheries catch information, and global ocean physical models are used to obtain preferable areas for yellowfin tuna. A map developed with the potential fishing areas and depths are disseminated for long-line vessel owners and skippers. The produced maps are published on weekly basis and disseminated via email, telephone, radio and WhatsApp. The Facebook page (www.facebook.com/tuna.forecast) and Department of fisheries registered skippers Facebook group (දිවර දෙපාර්තමේන්තුවේ ලියාපදිංචි නියමු ඵකතුව)are received information. Further, Dialog sayuru also disseminates fishing ground advisories via TV screens fixed at 8 fisheries harbours and through its Facebook page.

In addition to that an experimental forecast of skipjack tuna fishing grounds was launthed for multi-day gillnet vessels. The forecast maps are issued three days per week (Monday, Wednesday, and Friday). Awareness programs were conducted to aware fishers, vessel owners and government officials.

The sea-level monitoring program

This program aims to provide information on changes in sea level data periodically. The maintanance of existing sea level monitoring stations, monitoring of sea level trends, installation of instruments to the stations and development of "Sea Level" web portal are main activities conducted under the program.

Monitoring of Ocean currents and other parameters

The program aims to monitor the spatio-temporal variations in costal currents, physico-chemical properties, plantation diversity and occurrence of marine pollutants.
The findings revealed variations in wind-stress and the consequent impact on ocean mixing, fluctuations in nutrient loading and plankton diversity, and the increase in particulate pollution.

Assessment of hydrology and water circulation pattern in Lagoons

The study aims to assess the hydrological parameters including the quantity, distribution, flow pattern, and quality of the water and sediment to simulate the hydrologic, hydraulic, geological conditions in the lagoon.

Geological and geophysical investigations in continental shelf

This study aims to map the construction sand resources in the continental shelf of the country, as an alternative to the river sand. The main parameters investigated are grain size, quantity, chloride and shell content. More on, heavy mineral concentration was investigated by employing gravity method which was further confirmed with microscopic analysis.

SOCIO-ECONOMIC AND MARKETING RESEARCH DIVISION

Value chain analysis of Sea cucumbers and edible Oysters

The main objective of the study was to find out suitable value chains for edible oysters and sea cucumbers in Kalpitiya and Mannar districts of Sri Lanka. The results found that the edible oyster value chain was undeveloped and only two players were involved such as farmers or collectors and buyers. Further, neighboring hotels occasionally purchase a small quantity of edible Oyster to cater the tourist demand. The value chain of sea cucumber was well-established which consists with divers, middlemen and exporters. Difficulties in obtaining licenses, the high cost of fuel and poor post-harvest handling practices were major barriers for the value chain development of Sea cucumbers and edible Oysters in the area.

Socio-economic Impact Assessment of X-Press Pearl Ship Burning-2022

This study aims to evaluate the impacts of X-press pearl ship burning incident on socio-economic and marketing aspects of coastal fishers in Negombo, Colombo and Kalutara fisheries districts. Impacts were assessed in terms of fish production, marketing, fishers' income, and the social and perception of fishers on environmental damages from the ship burning incident.

KADOLKELE REGIONAL CENTER

Impacts of water quality and seasonal changes for Sea bass *(Lates calcarifer)* cage culture in lagoons

The aim of this study was to analyse in-situ water quality parameters and compare with baseline data. Water temperature, pH, electrical conductivity, total dissolved solids, salinity and resistivity were measured using CyberScan Series of 600 Meter. Results found the values of pH, EC, salinity, total dissolved solids, water temperature and resistivity were in the ranges of 6.88 - 9.71; 20.47 - 46.94; 0 - 28.2; 6.63 - 45.82; 29.88 - 30.34; and 11.73 - 67.08, respectively. It was observed mortality of fish with depletion of salinity and occurrence of toxic algal bloom during the month of June. High transport cost and low-quality fingerlings were major constraints in cage culture in lagoons. Fishermen who engaged in sea bass culture are requesting for high quality fish feed at a reasonable price. It is suggested actions should be taken to minimize the conflicts with other resource users in lagoons and assessment of quality parameters in lagoon waters.

KALPITIYA REGIONAL CENTER

Biology and socio-economics of Gastropod fisheries

The aim of the study was to determine the economic value of gastropod fishery by estimating the CPUE in the north-west coast (Mannar and Puttalam districts). Under this identification of species specificity, size composition, reproductive pattern, maturity pathway, and morphometric relationship as well as socioeconomic factors of dependents were analysed.

Results revealed that Pleuroploca trapezium (Horse conch), was the most frequently harvested species in Kalpitiya followed by Chicoreus ramosus (Branched murex) and Turbinella pyrum (Divine conch/Sacred chank). These three species are among the four that have been reported in Mannar, while C. ramosus being the most frequently captured species. Giant spider conchs, or Lambis truncate sebae, are only found in Mannar and are less economically valuable. Due to their edible flesh, P. trapezium and *C. ramosus* have a high economic value. The operculum of those species is also of the highest value and is exported to Malaysia and India. It was found that P. trapezium contributed over 95 percent to the gastropod landings and CPUE (201 ± 43)for a boat per day.The most challenging barrier was accumulation of the empty shells in the area.

Biological aspect of fyke net fishery in lagoons

The aim of the study was to assess significance of fyke net fishery in Puttalam lagoon through the target species, by-catch species and biological variations associated with fish.Results found that *Metapenaeus moyebi* is the most prevalent species of shrimp, accounting for 46% followed by Penaeus indicus, which accounting for 24% to the total annual shrimp production. Further, the average catch reaches its maximum in January (0.635 kg/trap) and reaches its minimum in June (0.114 kg/trap). The highest and lowest average catch were reported as 0.561 kg/trap and 0.155 kg/trap during the inter-monsoon and south-west monsoon respectively.The average by-catch rates reachedthe highest and lowest values 0.984 kg/trap and 0.033 kg/tarpin January and Decemberrespectively. It is suggested by-catch reduction devices (BRDs) should be used instead of conventional fishing techniques in shrimp fisheries to lessen by-catch.

KAPPARATHOTA REGIONAL CENTER

Suitability assessment of deterrent pingers against depredation of hooked yellow-fin tuna

The aim of the study was to mitigate the effects of marine mammal interactions on long line fishing gear based yellow fin tuna fisheries. Previous studies report that five species of Odontocetes are responsible for the depredation in long line fishery. It is suggested need of introducing advanced technologies to minimize the depredation of fish. Project plans to conduct studies on effectiveness of dolphin deterrent pingers in order to increase the number of undamaged yellow-fin tuna hauled on board of fishing boat by lowering the depredation losses of yellowfin tuna hooked in longline fishing gear during fishing in deep sea.

PANAPITIYA REGIONAL CENTER

Development of cost-effective fish feed and culture practices for ornamental fish species

The aim of the study was to develop and supply of cost-effective ornamental fish feed, brooders and adults for the industry. In the study two feed trials, one incorporating local fish oil and the other incorporating imported fish oil were tested for Koi carp. Result found that the feed developed using local fish oil was cost-effective and nutritionally balanced. Further, use of local fish ingredients such as soya bean and maize were economically support to lower the feed production cost for ornamental fish species.

REKAWA REGIONAL CENTER

Livelihoods development of inland and coastal fishers

The aim of the study was to introduce Tilapia cage culture in Rekawa Lagoon as an alternative livelihood for fishers and increase the survival and recapture rates of freshwater prawn post larvae in Kattakaduwa and Bandagiriya reservoirs. Four net cage sizes of 2×2 m were introduced to two selected fishermen in the Rekawa lagoon, and initially, nearly 500 fingerlings were stocked as an alternative livelihood activity.

Results found that culturing of Macrobrachium rosenbergii post-larvae for extended period of about 45 days in net cages at density of 694 larvae/m3over 45 days resulted in high weight gain (average 649 mg) and about 60% of survival rate. Further, post larvae of Macrobrachium rosenbergii gained average 400 mg of weight at density of 67 larvae/m3over 54 days in net pens (20×25×1.5 m, mesh size of 2 mm) with approximately 50% survival rate in Kattakaduwa reservoir.

Moreover, rearing of 15 day old post larvae of freshwater prawn for additional 45 days in cages or pens and then stocking will increase freshwater prawn production in reservoirs. Salinity fluctuation was observed during the study period, and it ranged between 0 - 19 ppt. The lowest average salinity level of 2 ppt was observed in November while the highest was recorded in July and October (12 ppt), followed by August (9 ppt).

EXTERNALLY FUNDED PROJECTS

SN	Project Name
01	Study on physical, chemical and biological parameters in Puttlam lagoon
02	Study on the environmental impacts to marine resources due to Lakvijaya power plant
03	Ocean country partnership program (OCCP) - Marine littersand micro plastic research project
05	Ensuring food security through minimizing post-harvest losses in fishery industry
06	Responsible use of fisheries and aquatic resources for sustainable development
07	Effects of wind turbine generated sound on fish in shallow water
08	Bathymetric survey in Norochcholai for production of the Nauticla chart of Puttalam
09	Bathymetric Survey for CEB in Silawathura
10	Side Scan Sonar Survey at near shore areas
11	Level survey for the Dutch canal
12	Mapping for demarcation of areas in the sea cucumber export village in Northern Province
13	Lagoon Survey at Arugambay Lagoon
14	CTD Profiling
15	Beach front- Mega Police project
16	Environmental monitoring work for East container terminal project of port of Colombo - Phase II
17	Nor-Lanka- Blue Project

COOPERATE AWARENESS, EXTENSION AND STUDENT SUPERVISERIES

AWARENESS AND EXTENSION

- A demonstration session on processing and packaging of fishery products for the students of the Ocean University
- Awareness of Skippers and owners of multi-day fishing boats about potential fishing ground forecasts developed by NARA
- A training program on breeding and live feed conducted by NARA
- Supervision of community based project of Ornamental Aquatic plants constructed in Colombo, Gampaha and Kaluthara District
- Production of Crypocoryne wendtii plants for ornamental sector
- Provide artemia testing services for outsiders and issuing of test reports on artemia hatching rate
- 10 workshops for Navy officers
- Routine awareness program on hydrographic surveying and chart production for undergraduates and school children
- A awareness program on World Fisheries Day
- 3 exhibitions in Rathnavali Balika Vidyalaya/Gampaha, Anura Central College/ Yakkala, and National Zoological Garden/ Dehiwala

STUDENT SUPERVISIONS

22 undergraduate students and 22 intern students from 14 Universities in Sri Lanka

University of Colombo
University of Jaffna
Ocean University of Sri Lanka
University of Kelaniya
South Eastern University of Sri Lanka
Open University OF Sri Lanka
University of Peradeniya
Rajarata University of Sri Lanka
Horizon campus
University of Sri Jayawardenapura
Wayamba University of Sri Lanka
General Sir John Kotelawala Defence University
University of Ruhuna
Sabaragamuwa University of Sri Lanka

TECHNICAL, ADVISORY, CONSULTANCY AND TESTING SERVICES

National Charting programme

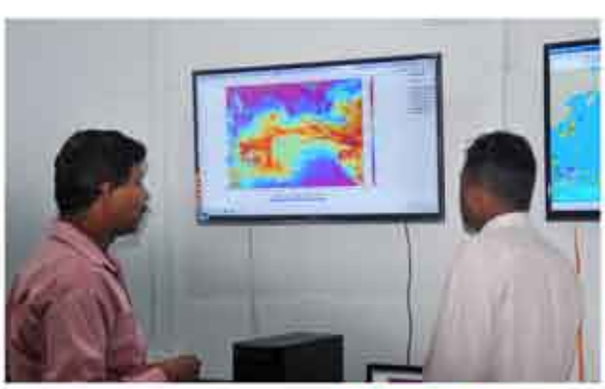
The prime objective national charting program is to provide information on safety of navigation under the SOLAS convention. National Hydrographic Office of NARA is the responsible body to conduct hydrographic surveys in inshore, near shore and offshore up to the Exclusive Economic Zone of Sri Lanka. The nautical charts are provided to relevant parties through an established channel and being utilized for safety navigation around the Sri Lankan sea. Further it provides information to enhance the marine protection, defense activities and exploration of living and non-living resources, research and development, coastal engineering, disaster management and delimitation of the national maritime jurisdiction of the country.
Under the charting program rapid hydrographic surveys in Hikkaduwa, Kirinda, Kudawella, Mirissa, Panadura, Puranawella and Tangalle fishery harbors were conducted to facilitate fisheries livelihoods. Furthermore, a side scan sonar survey was conducted in the coastal stretch from Colombo to Panadura to search sea bed debris in order to facilitate safe navigation. Over 300 derbies and locations were mapped to facilitate the removal process.

RV Samudrika Research Vessel and Small Survey Vessels

NARA bestows with the RV Samudrika research vessel equipped with state-of-the-art survey facilities including the multi-beam eco sounder system, single beam echo sounder, sub bottom profiler, side scan sonar, ADCP system and DGPS system to conduct hydrographic and oceanographic research activities. This research vessel is being utilized for gathering offshore chemical and biological data and near shore bathymetric data, oceanographic and geographic data for scientific research. The **RV Samudrika Research Vessel** is the only research vessel Sri Lanka possesses for maritime research within its jurisdiction. Apart from that NARA possesses two small vessels with its research fleet to facilitate near-shore research activities.

Tuna fishing ground forecasting and mapping

NARA engages in developing the tuna fishing ground predictions since 2008. In estimating the environmental preferences of yellowfin tuna, NARA acquires fisheries logbook data and relevant satellite and oceanographic data. The skipjack tuna fishing ground forecasting system was activated and commenced issuing of forecasts in May 2022. A map with highlighting the possible areas that skipjack tuna to be located is issued and it is valid up to five days. The forecast is created using satellite imagery, oceanographic information, and fisheries data. By providing this forecast, gillnet fishers can effectively plan their fishing cruises before departing from the port. The maps and fishing ground predictions are disseminated to fishers through email, web platforms, WhatsApp, facebook, and telephone.



Aquaculture Research Center

NARA maintains an aquaculture research center with the prime objective of developing technical knowhow and livelihoods of ornamental fish breeders and farmers in the country through catering the needs of operational research on food fish, ornamental fish, and marine invertebrate farming and induced breeding technologies. Further, it provides institutional and research facilities for students to pursue their undergraduate and postgraduate research studies.

Laboratory services

The Analytical Chemistry Laboratory (ACL) is authorized to carry out researches and testing services related to chemical parameters of aquatic resources. ACL is an ISO/IEC accredited laboratory for histamine analyses. The quality control laboratory is an ISO/IEC 17025:2017 certified laboratory and carries out microbiological assessments of water (seawater, coastal water, potable water, freshwater, and ice), fish, shellfish (chilled, frozen and canned) and dried fish.
The laboratory services for identification of shark fins, skins and jaws, sea shells, testing of ambergris, analysis of suspected dynamited fish and aquatic organisms by molecular methods. The laboratory services for wastewater testing, physicochemical analysis of water and wastewater as per the requirement of state and private sector institutes and general public. These testing facilitate the Environmental Protection Licensing (EPL) procedure of the Central Environment Authority of Sri Lanka.

Regular training and awareness programs

NARA conducts regular training and awareness programs every year on ornamental fish breeding and culture, aquatic plan tissue culture, fish feed production, management of ecosystem and restoration, cage culture farming and the "southern aqua" ornamental fish exhibition annually.

Marine Museum

NARA maintains a marine museum to home a priceless collection of marine specimens including preserved samples of momentous finfish and non-finfish resources, conventional fishing gear, sand and mineral collections for the enhancement of knowledge on history and chronological development of the fisheries resources and industry of the country.

Library

NARA Library provides books, journals, magazines and other printed documents relevant to the fisheries and aquatic resources conservation and management, fisheries biology, general management, social sciences and physical sciences on borrowing and in house use. NARA Scientists, students from universities and general publics are benefited from the services. The library maintains an e-repository to reuse national and international articles related to the fisheries and aquatic living and non-living resources.

Fisheries Information Center (FIC) - 0710101010

The FIC aims to provide real-time information and data related to the fisheries and affiliated industries as per the requirement of all stakeholders, general public, academics, and researchers through a hotline – 0710101010 since 2013.

Resource Conservation

NARA has been engaging in maintaining of a Turtle conservation unit in Rekawa regional center and mangrove nursery in Kadolkele regional center for the conservation and management of these animal and plant species. During a year a large number of students and general publics are entertaining these facilities.

Public Services

NARA provides public services as per the requirement of general public over the years as usual. During the year it conducts several programs such as beach cleaning programs, selling of mangrove plants, ornamental fish species and fish feed produced from local ingredients. All stakeholders can be purchased advisory reports, posters and booklets prepared by NARA scientists from the NARA library.

PUBLICATIONS, AWARDS AND PATENTS

ANNUAL PUBLICATIONS OF NARA

NARA Journal

The Journal of National Aquatic Resources Research and Development Agency (NARA) is a peer reviewed and a biannual publication with two issues per volume. Manuscripts submitted as papers of original research, review articles or short communications, brief technical notes, news and announcements relate directly or indirectly on living or non-living aquatic resources, utilization and management be considered for publication.

NARA Scientific Sessions Proceedings

The NARA Scientific Sessions 2022 was held as a virtual mode with the theme of "Collective Action for Blue Economy" in harnessing blue resources in sustainable way. A total of 78 abstracts were presented under a wide range of themes including Fisheries and Aquaculture, Aquatic Biotechnology and Animal Health, Oceanography and Hydrography, Fisheries Socio-economic and Marketing, Aquatic Postharvest Technology, Aquatic Environment, Conservation and Management, Climate Change, Application of GIS and Remote Sensing in Aquatic Sciences.

FULL PAPER PUBLICATIONS

01 Anutaliya, A., Send, U., McClean, J.L., Sprintall, J., Lankhorst, M., Lee, C.M., Rainville, L., Priyadarshani, W.N.C. and Jinadasa, S.U.P. (2022). Seasonal and year-to-year variability of boundary currents and eddy salt flux along the eastern and southern coasts of Sri Lanka observed by PIES and satellite measurements. Journal of Physical Oceanography, 52(12), pp.3015-3031.

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THESIS/ BOOKS/BOOK CHAPTERS

01 Weerasekara, K. A. W. S. (2022). Water quality assessment of drinking water wells in Madawachchiya and Padawiya Reservoir and health risk assessment of reservoir fish consumption: Implications for chronic kidney disease of unknown aetiology of the north central province, Sri Lanka. Ph.D. Thesis, University of Kelaniya

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03 Perera, G.C. (2022). Development the sustainable and practical feeds for the nursing of Guppy (Poecilia reticulata). A common ornamental fish. Ph.D. Thesis, Asian Institute of Technology (AIT), Thailand

TECHNICAL/ ADVISORY REPORTS

SN	Report Title
1	Rapid Assessment of On-going Sea Cucumber Farming Practices and its Implication on Fisheries Livelihood's at Kiranchi and Parititivu in Northern Province of Sri Lanka.
2	Design and Construction of Artificial structures (Fish Aggregating Devices) to enhance Fish habitats and increase Fish production in Coastal water.
3	Fishing dispute report on Thalan kalapuwa fishing net issue.
4	Seasonal and short-term fishing landing site, Patanangala in Block one of Yala national park
5	Study report on Half beak fishery nets used in Batticoloa area
6	The fishing efficiency comparison between Monofilament nets and Nylon nets used in inland reservoirs of Sri Lanka
7	Report on X-press Pearl Ship Fire Incident – bio monitoring of the coastal and shore ecosystems along the beach from Chilaw to Kerawalapitiya.
8	Report on suitability of the site proposed by Indigo Aqua International (PVT) Ltd for nursing early-life stages of sea cucumbers in Puttalam Lagoon
9	NARA Observations and recommendations on "Request for sea cucumber farming at three selected lo cations in Puttalam Lagoon

PATENTS AND AWARDS

Patents
Patent no: 14800
The novel processing technology for preparation of TilapiaMaldives fish
Patent Holder:National Aquatic Resources Research and Development Agency
Inventors

1. Pradeepa Symali Jayasinghe

Patent no: 18835

Extraction of food grade agar from *Gasilaria verrucosa* and Development of agar incorporated set-yoghurt product

Patent Holder: National Aquatic Resources Research and Development Agency
Inventors

1. Paththuwe Arachchige Maduni Jayahansi Wijepala
2. Geevika Janadari Ganegama Arachchi
3. Manthara Arachchige Jagath Wansapala

International Classification (IPC): A23C 9/00