Intergovernmental Oceanographic Commission

IOC/IOCARIBE-ANCA

Report of the IX Meeting of the HAB-ANCA-IOCARIBE Group November 2023

Summary

To identify potential alliances that strengthen actions aimed at overcoming the negative impacts of Harmful Algal Blooms (HABs) in the Caribbean region and its adjacent waters, the HAB-ANCA-IOCARIBE working group held the IX Regional Workshop virtually on Monday, November 20, 2023. The workshop was attended by 93 out of the 106 registered participants from 28 countries of America, Africa, Asia, and Europe.

Experts from the region and IOCARIBE-UNESCO focal points from Colombia, Costa Rica, Cuba, El Salvador, Guatemala, Martinique, Mexico, Panama, and Venezuela presented the most significant advances in research, monitoring, and capacity development achieved at the national level over the past two years. They also identified the main needs and proposed actions framed within the United Nations' Ocean Decade, emphasizing the need to advance in the co-design of Early Warning Systems for multiple marine threats.

Throughout the four-hour duration of the workshop, there was an emphasis on the urgency of joint actions with the public health sector of the different IOCARIBE member countries. It was also agreed to strengthen regional training in the taxonomy of potentially toxic microalgae through the IOC-UNESCO HAB program, increase efforts in the registration of toxic events on the HAIS-HAEDAT platform, and participate in the HAB-S program proposed by IPHAB to address the proliferation of harmful algal blooms. This initiative is structured around four thematic axes: Prevention and mitigation of harmful algal blooms, observation technology, access to data, and HAB literacy.

It was agreed to participate in the Call for Decade Actions #6, which offers financing opportunities and is aimed at the Small Island Developing States (SIDS) of Africa and the Caribbean, with a deadline of December 10, 2023.

Finally, it was proposed that the next regional workshop be held in person during the first semester of 2024 in Panama.

Development of the Agenda

The opening was led by Lorna Inniss, Director of IOCARIBE, who spoke about the United Nations' Decade of Ocean Science for Sustainable Development (2021-2030). During her intervention, she emphasized that despite the excellent work done by the HAB-ANCA groups, the majority of the population in the tropical region of the Americas and the Caribbean is unaware of the scope of this work. She also acknowledged that the group has become smaller than it was two decades ago and, therefore, stressed the importance of holding more frequent face-to-face meetings, including representatives not only from the scientific community but also from groups impacted by harmful algal blooms, such as fisheries and the health sector. The relevance of working together with teams in the ocean sciences supply chain was mentioned, and groups and individuals involved in these issues were invited to contact the HAB-ANCA-IOCARIBE group led by Gustavo Arencibia to ensure their participation in regional initiatives. Finally, she emphasized that harmful algal blooms are affecting many communities and that, unfortunately, the environmental crisis due to pollution, and losses and degradation of ecosystems related to climate change, masks some regional issues. She concluded by stating that one task of the HAB-ANCA group is to generate information for society in general and, in particular, for those designing public policy instruments, providing tools to contribute to ensuring human health in the Caribbean region and its adjacent waters.

Gustavo Arencibia-Carballo, President of HAB-ANCA, presented the objectives of the meeting, emphasizing the need to integrate more researchers from IOCARIBE member countries into the HAB-ANCA working group.

With a view to identifying common interests and potential alliances for future work, J. Ernesto Mancera presented a synthesis of the HAB-ANCA group.

Contribution HAB-ANCA-IOCARIBE - J. Ernesto Mancera [1]

1 National University of Colombia, Bogotá Campus

Objective of the presentation: Inform about what HAB-ANCA IOCARIBE is and its history.

This group seeks to establish alliances among all those working on Harmful Algal Blooms (HAB), a cross-cutting issue involving various sectors of society and areas of knowledge.

The countries with the highest historical participation in the ANCA group are a total of 12: Barbados, Colombia, Cuba, Costa Rica, El Salvador, Guatemala, Honduras, Jamaica, Martinique, Mexico, Panama, Venezuela.

What does ANCA mean?
It stands for Harmful Algae of the Caribbean and is a network or working group belonging to the IOC Caribbean sub-commission (IOCARIBE) that aims to improve knowledge about these phenomena throughout the Caribbean region and adjacent waters, i.e., the Pacific waters of the member countries.

IOCARIBE is responsible for promoting, developing, and coordinating research and the development of scientific programs in marine sciences, considering two fundamental aspects: the specific interests and needs of the member states.

Approximately 30 countries are IOCARIBE members and have implemented programs on various topics such as the development of observational and numerical models, tsunami alerts, bathymetric mapping, data management and oceanographic information, and **harmful algal blooms (ANCA)**, among others.

On the other hand, the HAB-ANCA working group is part of the HAB-IOC Program, led by the Intergovernmental Panel IPHAB. The HAB-IOC Program includes numerous task groups as well as regional groups equivalent to ANCA, such as FANSA, WESTPAC/HAB, and HANA.

More information about the HAB-IOC program can be found at: https://hab.ioc-unesco.org/anca/.

The importance of improving communication is emphasized, and the Harmful Algae News journal is mentioned as a very useful tool, widely circulated, where workshops, seminars, reports, and projects are published. Participants are invited to make use of this valuable resource.

ANCA Group Objectives
- Collect and analyze information that allows decision-making related to HABs in the Caribbean region.
- Identify and characterize the microalgae responsible for intoxications (PSP, DSP, ASP, NSP, Ciguatera), as well as toxin vector species in the Caribbean and adjacent areas.
- Train HAB researchers for the region, taking advantage of existing knowledge in the Caribbean and international cooperation.

The HAB-ANCA group was born in 1996 as a result of an initiative by Cuban researchers regarding problems caused by intoxications from marine fishery products and deaths of people in Caribbean countries. Reports date back to 1977 in Venezuela with 277 intoxicated

and at least 10 deaths, followed by Mexico in 1979 and 1987 with 99 intoxicated and 6 deaths, Guatemala in 1987 with 187 intoxicated and 26 deaths, and Cuba in 1994-1997 with 1144 intoxicated and 10 deaths. This raised alarms, and the initiative was taken to the IOC, leading to a series of training sessions between 1996 and 2012 for a total of 67 researchers in partnership with the Oceanographic Center of Vigo in Spain and also with Copenhagen, focusing on taxonomy and identification of the algae causing HABs. Since then, the group has been meeting periodically, approximately every 2 years, although currently, the meetings are held virtually. In these meetings, each country presents progress on HAB-related topics and proposes solutions to problems and collaboration with various sectors of society.

Alliances

Through IOC management, there has been a rapprochement between the HAB-ANCA group and the International Atomic Energy Agency (IAEA) in recent years. This agency has funded various research, training, and infrastructure projects for Caribbean countries, with HAB-ANCA focal points participating. As a result of these initiatives, there is currently significant technical capacity in the region to address HAB phenomena.

The existence of two reference centers for biotoxin analysis is highlighted, one in Cienfuegos, Cuba, and another in El Salvador, as well as the configuration of national committees in different countries responsible for designing and implementing permanent monitoring.

Latest activities and products

With the support of IOCARIBE and the universities and institutes to which the focal points belong, the HAB-ANCA group has developed various research, monitoring, training, and outreach activities, resulting in products such as:

- Informative posters on ciguatera.
- Informative book on ciguatera.
- HAB Course - Virtual reality UNAL Colombia.
- Scientific article on the contribution of Latin America and the Caribbean to the global report on Harmful Algal Blooms.

The progress of some countries in the development of early warning systems is also highlighted, making it essential to strengthen participation in entering HAB events into the HAIS-HAEDAT platform.

Some participants in the IX HAB-ANCA workshop asked questions and made contributions related to potential alliances.

Contribution REMARCO - Luisa Espinosa [1]

1 INVEMAR

Through Colombian projects, REMARCO (Coastal Marine Stressors Network for Latin America and the Caribbean) has been strengthened. This network addresses the issue of harmful algal blooms, generating information and working in the regions. The proposal is to link and collaborate in the region as a strategy to minimize resource use, as REMARCO is conducting training that can be included within the framework of the Ocean Teacher Global Academy (OTGA).
Additionally, there is a suggestion to involve the health sector in REMARCO. Together with collaborative work, a regional strategy is proposed to tackle Harmful Algal Blooms.

Country Reports

Colombia - Presented by José Ernesto Mancera [1]

1 National University of Colombia, Bogotá Campus

The Colombian HAB group is part of the National Technical Committee on Marine Pollution.

I. Advances in Research and Monitoring:
Monitoring. INVEMAR currently has permanent phytoplankton sampling stations along the Colombian coasts in order to determine the density and presence of potentially harmful microalgae and to evaluate the spatiotemporal dynamics of the composition and density of potentially harmful phytoplankton in coastal areas.
There are 9 stations in the **Caribbean**:

- Monthly sampling from 2010 to date at 2 stations in Santa Marta and Tayrona National Natural Park and, at 2 stations located in the Ciénaga Grande de Santa Marta.
- Monitoring of benthic dinoflagellates at 2 stations in the Tayrona National Natural Park.

On the **Pacific** coast, specifically in Buenaventura, there are 3 stations where biannual phytoplankton monitoring has been conducted since 2018.

Research. Advances in research are based on information gathering and projects that are currently under development, listed below:

2022-2023

- Compilation of mass fish mortality events due to Harmful Algal Blooms in the Ciénaga Grande de Santa Marta, Colombian Caribbean. National University of Colombia
- National Project COL/7/004 IAEA-INVEMAR: "Strengthening of national capacities for the detection of marine biotoxins during harmful algal blooms".

2022-2024

- TOXICROP "Cyanotoxins in irrigation waters: monitoring, risk assessment and innovative remediation proposals". - INVEMAR and the University of Aarhus, Denmark
- Improve national capacities for cyanotoxin analysis and implementation of constructed wetlands to decontaminate water bodies.

2022-2025

- Regional Project ARCAL RLA/7/026 IAEA-INVEMAR: Evaluation of organic and inorganic environmental contamination in rivers, lakes, reservoirs, and lagoons in Latin America and the Caribbean, and their impact on the risk of proliferation of cyanobacteria producing cyanotoxins that affect human health.

II. Capacity Development

Capacity development focused on workshops, roundtables, projects, and a doctoral thesis, each listed below:

2021

- WORKSHOP: "Colombia preparing for HAB: Participatory construction of a National Contingency Plan to deal with events caused by Harmful Algal Blooms (HAB)" - Project COL7004 IAEA - HAB Table.
- WORKSHOP: II Working Table "Towards an Early Warning System (EWS) for events caused by Harmful Algal Blooms (HAB)". Project COL7004 IAEA - HAB Table.

2022

- "HAB Table Meeting - HAB Event Response Plan" Project COL7004 IAEA - HAB Table.
- "Diagnosis of Ciguatera poisoning" Project COL7004 IAEA - Mesa FAN.
- "Cyanobacteria and cyanotoxins, a problem for aquatic ecosystems and a challenge for integrated water resource management in coastal areas" TOXICROP Project - University of Aarhus.

2023

- WORKSHOP: "Research advances in risk factors for water quality and remediation proposals for integrated water resource management in coastal areas" TOXICROP Project - University of Aarhus.
- WORKSHOP: "Risks and environmental impacts of harmful algal blooms" Project COL7004 IAEA - Mesa FAN.
- Doctoral Thesis: Influence of Resources and Regulators on the Population Abundance of Benthic Dinoflagellates of the South-Western Caribbean on Daily Scales. National University of Colombia, Caribbean campus. Edgar Arteaga. PhD in Sciences, Marine Biology. Submitted October 27, 2023. Laureate mention.

III. Products generated

Publications of scientific articles mentioned below:

Salzwedel, H., Mancera-Pineda, J.E. 2023. La Ecorregión colombiana Ciénaga Grande de Santa Marta en los medios públicos, 1990 a 2020. Editorial Universidad del Magdalena.

Mancera-Pineda, J.E., Gavio, B., Santos-Martínez, A., Arencibia Carballo, G., Prato, J. In press. Ciguatera in the Seaflower Biosphere Reserve: Projecting the Approach on HABs to Assess and Mitigate their Impacts on Public Health, Fisheries and Tourism. In Climate Change Adaptation and Mitigation in the Seaflower Biosphere Reserve: From Local Thinking to Global Action. Mancera-Pineda, J.E., Osorio-Arias, A., Toro, C., Velasquez-Calderón, C.S., Ed. Springer Nature.

Mafra, L.L., Sunesen, I., Pires E, Mattos Nascimento, S., Alvarez, G., Mancera-Pineda, J.E., Torres, G., Carnicer, O., Huamaní Galindo, J.A., Sanchez Ramirez, S., Martínez-Goicoechea, A., Morales-Benavides, D., Valerio-Gonzàlez, L. 2023. Benthic harmful microalgae and their impacts in South America. Harmful Algae 127:102478. https://doi.org/10.1016/j.hal.2023.102478

Arteaga-Sogamoso, E., Rodríguez, F., Amato, A., Begoña Ben-Gigirey, Fraga, S., Mafra Jr. L.L., Fernandes, L.F., de Azevedo Tibiriç, C.E., Chomérat, N., Nishimura, T., Homma, C., Adachi, M., Mancera-Pineda, J.E. 2023. Morphology and phylogeny of Prorocentrum porosum sp. nov. (Dinophyceae): A new benthic toxic dinoflagellate from the Atlantic and Pacific Oceans. Harmful Algae 121:102356. https://doi.org/10.1016/j.hal.2022.102356

Gavio, B., Prato, J., Gnecco, M., Maya, M.F., Mancera-Pineda, J.E. 2022. Bloom of Trichogloeopsis pedicellata (rhodophyta, nemaliales) following hurricane Iota in San Andrés, Southwestern Caribbean Sea. Front. Mar. Sci. https://doi.org/10.3389/fmars.2022.978869.

Arteaga-Sogamoso, E., Riobo, P., Rodríguez, F., Mancera-Pineda, J.E., Franco-Angulo, J. 2022. First record of the dinoflagellate Prorocentrum borbonicum in the continental coast of Colombian Caribbean: A new 42 hydroxi-palytoxin producer.

Arteaga-Sogamoso, E., F. Rodríguez, J.E. Mancera-Pineda. 2021. Morphological and molecular characterization of Gambierdiscus caribaeus (Dinophyceae), with a confirmation of its occurrence in the Colombian Caribbean Tayrona National Natural Park. Botanica Marina. https://doi.org/10.1515/bot-2020-0070.

Sunesen, I., S.M. Méndez, J.E. Mancera-Pineda, M-Y. Dechraoui-Botteind, H. Enevoldsene. 2021. The Latin America and Caribbean HAB status report based on OBIS and HAEDAT maps and databases. Harmful Algae 102:101920 https://doi.org/10.1016/j.hal.2020.101920.

IV. Relationship with other working groups

- Active HAB national group: Universities, research centers, Maritime Authority, ministries, among others.
- Involvement of the health sector (Ministry of Health, National Health Institute, National Institute for Drug and Food Surveillance - INVIMA).
- First draft document of the national contingency plan prepared -.
- Dissemination strategy of the national contingency plan to deal with events caused by harmful algal blooms (HAB) - INVEMAR.
- Attention protocol for events caused by harmful algal blooms in the coastal zone of the Department of Magdalena - INVEMAR.
- Cooperation with macroalgae group: Bloom of Trichogloeopsis pedicellata (rhodophyta, nemaliales) following Hurricane Iota in San Andrés, Southwestern Caribbean Sea.
- Participation in regional and global initiatives: Global HAB Status Report (IPHAB); Benthic microalgae in South America (FANSA & ANCA).

V. Group needs

The needs are focused on 3 key points:

- Manage agreements with the Ministry of Science and Technology, the Ministry of Environment and Sustainable Development, the Ministry of Tourism and private companies, to guarantee resources for research, monitoring, and training.
- Formulate national regulations and standards for marine biotoxins in seafood and coastal water bodies.
- Advance in the implementation of the National Contingency Plan for Harmful Algal Blooms.

VI. Proposal for the UN Ocean Decade:

UN Ocean Decade. Challenge 6:

Increase community resilience to ocean hazards.

"Improve multi-hazard early warning services for all geophysical, ecological, biological, meteorological, climate and anthropogenic ocean and coastal hazards, and incorporate community preparedness and resilience."

Knowledge Management for Public Policy Making: Develop and publish a historical compendium of HAB events for each country in the IOCARIBE region, including, if possible:

1. Species involved
2. Toxins
3. Impacts generated
4. Description of the events
5. Knowledge of local communities

Based on the compendium, advance in the co-design of public policy instruments in each country to address HAB issues.

In addition, the need to strengthen and consolidate knowledge to minimize the use of resources by working in an articulated manner among groups generating a regional strategy is mentioned.

Costa Rica - Presented by Maribel Vargas [1]

1 Research Centre on Microscopic Structures (Centro de Investigación en Estructuras Microscópicas CJEMIC) - University of Costa Rica

I. Advances in Research and Monitoring:

Monitoring

- Marine Mollusk-Phytoplankton Sampling 2023, carried out at the regional level by the Regional Directorates SENASA and INCOPESCA in coordination with the oyster farmers. Water samples for harmful/toxic phytoplankton analysis from oyster farms are collected by trained personnel and delivered to the National University staff for morphological analysis and species identification. This maintains a constant schedule for bivalve mollusk sampling and water sample collection. PSP toxin determination analyses, saxitoxins, are conducted weekly by the National Animal Health Service SENASA, of the Ministry of Agriculture. Additionally, sediments are analyzed and biochemical analyses are performed.

Research:

- On the Caribbean coast of Costa Rica, the presence of potentially ciguatoxin-producing species has been detected.
- In samplings since 2022, more than six species of dinoflagellates potentially producing ciguatera have been found, including those from the genera *Gambierdiscus, Collia,* and *Prorocentrum*. This year (2023), the species *Ostreopsis sp*. was found in intertidal zones of the central Pacific coast and on Cocos Island, located in the Eastern Tropical Pacific. Recently in the Caribbean region of Costa Rica, an increase in the concentration of dinoflagellates of the genus *Tripus* has been observed.
- During tours conducted by the University of Costa Rica, samples of benthic dinoflagellates were collected directly from reef areas, from which cultures were generated in the laboratory, but they did not grow well and died.
- Different methods for sample collection have been implemented, including collecting benthic dinoflagellates on submerged nets left in the water for 24 hours to allow microorganisms to approach and use the nets as protection.
- Recognition and collection projects for macroalgae.
- Projects for the collection and cultivation of *Gambierdiscus*.

II. Capacity Development

Participation in Congresses

1. Marine phytoplankton species producing Harmful Algal Blooms (HABs) on the Caribbean coast of Costa Rica, M. Vargas. 18th International Conference on Harmful Algae, October 21-26, 2018, Nantes, France.
2. Assessment of ciguatera benthic dinoflagellates from the Atlantic coast of Guatemala, E. Blanda, J. Garcia-Perez, M. Vargas-Montero, L. Carrillo-Ovalle. 18th International Conference on Harmful Algae, October 21-26, 2018, Nantes, France.
3. Potentially toxic species of the genus *Dinophysis* reported from the Pacific coast of Costa Rica. Maribelle Vargas Montero. 19th International Conference on Harmful Algae, October 10-15, 2021, Baja California, Mexico.

Courses

In recent years, the International Atomic Energy Agency (IAEA) through ARCAL projects has collaborated in conducting various regional courses and international internships for experts from our country and other countries in the Caribbean area. The aim is to learn and improve techniques in the study of taxonomy and toxicology of phytoplankton species through the following research projects:

1. Project RLA 7020 Establishing the Caribbean Observing Network for Ocean Acidification and its impact on Harmful Algal Blooms, using nuclear and isotopic techniques.
2. Project RAS 7026 Supporting the use of receptor binding assay (RBA) to reduce the adverse impacts of harmful algal toxins on seafood safety.
3. Project RLA 7014 Latin American regional proficiency test on the determination of trace elements and radionuclides in algae, soil, and spiked water.

III. Products

- Weekly report of biotoxins in commercial mollusk meat.
- Publication in the Tropical Biology Journal: Benthic species of the *Gambierdiscus* and *Collia* genera have been found on Cocos Island.

IV. Relationship with other Working Groups

Interinstitutional Commission for Prevention and Control of Red Tide:

- SENASA (National Animal Health Service)
- INCOPESCA (Costa Rican Institute of Fisheries and Aquaculture)
- Safety of Animal Origin Products of SENASA (National Animal Health Service)
- National Veterinary Services Laboratory (LANASEVE) of SENASA
- Health Surveillance Directorate of the Ministry of Health
- Epidemiological Surveillance of the Costa Rican Social Security Fund
- Marine Phytoplankton Laboratory of the National University
- University of Costa Rica

- Ministry of Environment and Energy

The University of Costa Rica currently presents joint projects with the International Atomic Energy Agency (IAEA).

V. Group Needs

- Training and equipment are necessary for the early detection of toxic events and the manipulation of cultures to extract toxins (PSP, ASP, DSP, NSP, Ciguatera...) that can be identified by chemical methods.
- Support is required to perform molecular analyses for species identification, regional support for coastal monitoring at the regional level, regional support for the implementation of endemic mollusk cultures for the area, and the possibility of supporting small oyster-farming associations, such as training and improving controls for red tide alerts.
- Support is needed to launch a regional project to study the incidence of ciguatera associated with coral reef areas, identifying the producing species and their toxins, thus supporting the national institutions responsible for the import and export of fish.

Cuba - Presented by Gustavo Arencibia [1]

1 Havana Centre for Fisheries Research (Centro de Investigaciones Pesqueras de La Habana, CIP)

The ANCA - Cuba Group is constituted by specialists from different disciplines of scientific institutions and the media. For the stage from 2019 to 2023, efforts have been dedicated to continuing with the creation of the database of the Early Warning System Ciguatera Risk Index (IRCIGUA). The above is in order to change the existing regulations and improve the control of intoxication associated with fishing and the knowledge of the communities, all within a framework of reducing the impact on national public health but with an ecosystemic approach.

I. Advances in Research and Monitoring

Monitoring. There is no national monitoring network, however, since 2019 through the Early Warning System (IRCIGUA) the country was divided into 9 ecoregions where phytoplankton monitoring is carried out, collecting data such as temperature, association of anthropogenic factors, geomorphology of the place, epidemiology, etc., to provide alerts on the presence of HAB on the coasts. This is with an ecosystem approach to ciguatera cases and outbreaks.

Research. All the working groups maintain their work plans depending on ongoing projects and needs, despite the national economic situation that prevents a more accelerated development of research and monitoring of the HABs. Research projections for 2024 contemplate a significant increase in work plans and actions for the formulation of regional

projects, and the problems associated with Sargasso upwelling in the Cuban archipelago are beginning to be addressed with greater interest.
At present, greater interaction between the institutions involved in these issues is required to guarantee better results.

II. Capacity development
Researchers and specialists undergoing training.
2 master's theses:

- Aimee Valle (Defended in 2022) Thesis title: "Strategic actions for the management of cyanobacterial blooms from the Integrated Watershed and Coastal Area Management approach".
- Gabriel L. Rojas (Defended in 2022) Thesis title: "Harmful Algal Bloom Monitoring and Management System (SVG-FANs) for the coastal areas of Cienfuegos province".

1 doctoral thesis:

- M.C. Lisbet Díaz Asencio (Defended in 2022). Concentrations of ciguatoxins in marine organisms of the south-central region of Cuba.

III. Relations with other work groups
Relations are maintained with scientific institutions whose research projects include HABs' lines of work, such as the Fisheries Research Center (CIP) and the Center for Environmental Studies of Cienfuegos (CEAC). It maintains links with MINAL through its polyclinics in the municipalities. In addition, scientific articles and international training courses have been developed with the National Toxicology Center (CENATOX) and the CIP.
An important contribution is outreach, so since 2021 we have been working with the radio station Radio Caibarién on issues related to Ciguatera. In addition, we are working with the fishing companies EPICAI and PESCATUN to disseminate printed materials on ciguatera and training conferences for the management sector. The results obtained in this area are considered relevant. In the future, a national project is being prepared to disseminate materials and programs on HABs.

IV. Products generated
Publication of 11 articles on various topics related to FANs mentioned below:

Catálogo de microalgas y cianobacterias de agua dulce de Cuba (Libro). Editora del Proyecto IWECO (GEF PNUD). A. Comas.

Cianobacterias de agua dulce formadoras de floraciones algales en Cuba (Libro). Editora del Proyecto IWECO (GEF PNUD). A. Comas.

A. Valle, A. Comas, A.R. Moreira, M. Sánchez, Y. Cubela. Limnoraphis robusta bloom in Hanabanilla reservoir, central-southern Cuba. Harmful Algae News (UNESCO) 2022, No. 70.

M. Seisdedo, A. Moreira, D. Carles. Assessment of water quality with emphasis on trophic status in bathing areas from the central-southern coast of Cuba. Ocean and Coastal Research 2022, V. 70: e22019.
M. Seisdedo, A. Moreira, G. Rojas. Evaluación de la calidad de agua y del estado trófico en áreas de baño de la bahía de Cienfuegos.Revista Universidad y Sociedad 2023, 15(S1), 143-154.

G.L. Rojas, M.E. Castellanos, C.E. Miranda, L. Díaz-Asencio, O. Hernández, L. Rojas, Á.R. Moreira. 2023. Sistema integrado para la vigilancia y gestión de floraciones algales nocivas en la provincia de Cienfuegos, Cuba.Rev. Mar. Cost. Vol. 2023, 15 (1): 75-98.

L. Diaz-Asencio, G.L Rojas, G. Pérez, D. Chamero, A. R. Moreira Clave dicotómica para la identificación preliminar de las especies de Gambierdiscus y Fukuyoa reportadas en la región del Caribe. Rev. de Investigaciones Marinas.

Arencibia-Carballo, G, Irañeta Batallán, J.M., Morell, J., Moreira González, A.R., 2020. Arribazones de Sargassum en la costa norte occidental de Cuba. JAINA Costas y Mares ante el Cambio Climático 2(1): 19-30. doi 10.26359/52462.0220

Valle, A.R. Moreira, D. Domínguez, A. Comas, J.M. Silva, C. Moreira, A. Campos, V. Vasconcelos. Non-specific cyanobacteria bloom and microcystin detection in Abreus reservoir, Cienfuegos, Cuba. MOL2NET23, Conference on Molecular, Biomed, Comput. & Network Science and Engineering, 9 th ed. Congress BIOMODE.ECO-08: Biotech. ISSN: 2624-5078.

Arencibia-Carballo, G.; Mancera, J. Ernesto; Delgado, G.; y L. Díaz. 2022. La Ciguatera Un riesgo potencial para la salud humana: Preguntas frecuentes. Libro 3ra Edición. http://hdl.handle.net/1834/41838 Martínez Milanés, A., Dellundé Granja, D., Pis Ramírez,

M.A., Ocano Busía, C.A., y G. Arencibia-Carballo. 2023. Estado del conocimiento de ciguatera en los poblados costeros de Jaimanitas y Santa Fe, La Habana, Cuba. Rev. Cubana de Investigaciones Pesqueras, En Prensa.

Arencibia-Carballo, G., Franco Mendoza, L.R., Aguilar Rios, A., y J.A. Tello Cetina. 2022, Toxicidad por Barracuda (Sphyraena barracuda) en la costa norte de la Habana, Cuba. Brazilian Journal of Animal and Environmental Research. ISSN 2595-573, v. 5, n.2, p. 2454-2473, abr./jun.,2022.

V. Group needs

They are based on 3 pillars:

- Training courses for researchers and technical staff.
- Technical field and laboratory equipment for monitoring and research.
- Funding for the permanent consumer protection outreach campaign in areas at risk from Ciguatera.

VI. Proposal for the UN Ocean Decade:

The creation of a regional project on Ciguatera is proposed, with an ecosystemic approach, which will have an impact on the training of researchers and communities. In addition, an order and effective proposals should be made in the legislation of the countries affected by this Foodborne Disease (FBD). The main objective is to strengthen the economy of coastal communities through safer fishing, coherent and safe legislation, and to achieve a better quality of life for the inhabitants of coastal areas.

El Salvador - Presented by Oscar Armando Amaya Monterrosa [1]

1 Laboratory on Marine Toxins, Faculty of Natural Sciences and Mathematics (Laboratorio de Toxinas Marinas, Escuela de Física, Facultad de Ciencias Naturales y Matemática) University of El Salvador, San Salvador 01101, El Salvador; oscar.amaya@ues.edu.sv

I. Advances in Research and Monitoring: Ongoing Projects

1. **Project Name:** Taxonomic Identification and Toxicity of HAB Algae. Marine Toxins Laboratory (LABTOX-UES).
   Description: During 2021-2023, this laboratory contributed scientifically to promptly respond to three events associated with "Red Tides" that occurred in the coastal zone (Gulf of Fonseca, La Libertad, Jiquilisco Bay, Los Cobanos, Mizata, Acajutla, etc.), and three blooms of microalgae and cyanobacteria in lakes and lagoons of El Salvador. In total, over 250 phytoplankton and toxin analyses were conducted on water and fishery products, maintaining a continuous dynamic with personnel composed of researchers and students from different schools within the Faculty of Natural Sciences and Mathematics. LABTOX-UES provided approximately 45 technical reports to government authorities in 2021-2023, prompting actions to issue bans on the consumption, commercialization, and extraction of mollusks, minimizing the impact of natural hazards on the population and safeguarding human lives.

2. **Project Name:** Evaluating Marine Plastic Pollution in Central America through the Formation of a Regional Research Network.
   Responsible parties: San Carlos University of Guatemala, in collaboration with the Technological University of Panama
   Progress Level: Multiple virtual meetings for the design phase
   Funding Source: CSUCA, the Central American Integration System (SICA), and the International Development Research Center of Canada

Future Projects 2023-2028

1. Approval of the national project submitted to the International Atomic Energy Agency (IAEA) for execution in the 2024-2025 period under the title "Nationally Determined Contributions for the assessment and monitoring of stressors in El Salvador's marine-coastal ecosystems in the context of climate change; Strengthening national capacities. ELS2022005. Preparation and submission of a project proposal formulated between MARN, ASA, and LABTOX-UES to the International Atomic Energy Agency for the 2024-2025 cycle; ESCO is creating conditions to submit it to the IAEA.
2. Approval of the project "Strengthening the regional capacities of Latin America and the Caribbean in the use of nuclear and isotopic techniques to increase knowledge of stressors affecting coastal areas and contribute to the sustainable management of marine resources" in conjunction with 18 countries in the region of Central America and the Caribbean. RLA2022007. 2024-2028

II. Capacity Development
Congresses

LABTOX-UES Director (Radioecology) Oscar Armando Amaya Monterrosa

- Speaker at the "V Biennial Central American and Caribbean Research and Graduate Studies Meeting." Presentation Title: Sea Turtle Mortality in El Salvador: Receptor Binding Assay Analysis Confirms Saxitoxin Findings. Organized by the National Autonomous University of Honduras, held virtually in November 2021.
- Speaker at the IV University Congress of Scientific Research of the Secretary of Scientific Research of UES, with the presentation "Harmful Algal Blooms in Freshwater Bodies of El Salvador." October 26-28, 2021.

Microscopy Unit – Rebeca Quintanilla's Participation:

- Speaker on harmful algal blooms at the Monaco Ocean Week, as part of the presentation "The Latin American and Caribbean Network for Research in Coastal and Marine Stressors – REMARCO, a cooperation strategy to facilitate decision-making in the face of common challenges and vulnerabilities in the marine environment," 2021.
- Poster presenter at the 19th International Conference on Harmful Algae, with the work "Blooms of the cyanobacteria *Limnoraphis* cf. *birgei* in a volcanic lake of El Salvador." October 10-15, 2021.
- Speaker at the IV University Congress of Scientific Research of the Secretary of Scientific Research of UES, with the presentation "Harmful Algal Blooms in Freshwater Bodies of El Salvador." October 26-28, 2021.

Training

Microscopy Unit – Rebeca Quintanilla's Participation:

- Participation in the course "Training Course on Strategic Planning/Management for Young Leaders" organized by the International Atomic Energy Agency, from November 24, 2020, to February 23, 2021.
- VIII Working Group Workshop "Harmful Algae of the Caribbean and Adjacent Regions" and the Intergovernmental Oceanographic Commission (IOC-CARIBE). March 3-5, 2021.

  Postgraduate Course "Functional Ecology of Phytoplankton" with a total of 80 virtual participants during the Summer School - La Paloma "Marine Sciences and Functional Aquatic Ecology" March 10-16, 2021, organized by the University of the Republic, Uruguay.

III. Generated Products

Oscar A. Amaya, Marie-Yasmine Dechraoui Bottein, Rebeca Quintanilla, Gerardo Ruíz. Sea turtle mortality in El Salvador: Analysis by receptor binding assay confirms saxitoxin findings. [Ed]. 2020. Proceedings of the 18th Intl. Conf. on Harmful Algae. Nantes. International Society for the Study of Harmful Algae. 214 pages. ISBN: 978-87-990827-7-3.

Mazariegos-Ortíz, C., Quintanilla, R., Delvalle-Borrero, D., Amaya-Monterrosa, O., Xajil-Sabán, M. 2022. Academics from Central America create a research network and monitor marine litter through citizen science. Ecosistemas 31(2): 2397. https://doi.org/10.7818/ECOS.2397

Fuentes-Monteverde, J.C.; Núñez, M.J.; Amaya-Monterosa, O.; Martínez, M.L.; Rodríguez, J.; Jiménez, C. Multistage Detection of Tetrodotoxin Traces in Diodon hystrix Collected in El Salvador. Toxins 2023, 15, 409. https://doi.org/10.3390/toxins1507040

IV. Collaborative Work

There is a network of collaboration among different institutions for timely information on toxicity/HABs/Red Tides.

- Ministry of Health MINSAL
- MARN
- MAG/CENDEPESCA
- Salvadoran Water Authority ASA
- National Red Tide Commission/CONAMAR
- Legislative Assembly/Environment and Climate Change Committee
- Non-Governmental Organizations (NGOs)

V. Group Needs

1. LABTOX-UES possesses specialized equipment that requires appropriate environmental conditions for its operation. The space and infrastructure conditions where it is located need improvements since there is a considerable space limitation, and safety conditions are not fully met. It is essential to have a larger space and an air conditioning system throughout the laboratory to preserve and extend the life of the equipment. These aspects are highly significant in the context of implementing the ISO/IEC 17025 standard and obtaining accreditation for the laboratory.
2. The stability of human resources can compromise the capabilities established and, ultimately, the sustainability of the laboratory. Permanent contracts are needed to maintain the work pace. Currently, the laboratory operates with two research assistants hired on an occasional basis and one Full-Time Senior Researcher.
3. There is a need for personnel to strengthen the Oceanography unit, as well as research assistants to support the Microscopy, Aquatic Pollution, and Radioecology units. This will allow LABTOX-UES and the University, in general, to expand their scientific activities.
4. There is no budget allocation for the laboratory, as a significant portion of the material resources and training comes from international cooperation.
5. Maintaining constant communication and scientific collaboration with the "el Bohio" newsletter and the IOC-ANCA-CARIBE, REMARCO, and REBAMAR networks is necessary.
6. There is a lack of funding for monitoring and fieldwork, which impacts the number of annual monitoring activities.

Guatemala - Presented by Karla Paz [1]

1 Institute of Hydrobiological Research, Centre of Studies of the Sea and Aquaculture (Instituto de Investigaciones Hidrobiológicas, Centro de Estudios del Mar y Acuicultura) University of San Carlos de Guatemala, Guatemala City, Guatemala

I. Advances in Research and Monitoring

In Guatemala, research on HABs began in 1987 when *Pyrodinium bahamense* caused the poisoning of more than 100 people, claiming the lives of 26 people.

During the years 2019-2022, sampling of algal blooms was conducted in Puerto Quetzal and Puerto San José on the Pacific coast of Guatemala. Samples collected were analyzed with inverted microscopy. Microalgal cells were identified and counted in a 1 ml Sedgwick-Rafter chamber (Reguera et al., 2011), and chamber counts were also performed using 50 ml sedimentation cylinders (decanting 2 h for each ml), according to the Utermöhl technique (Utermöhl, 1958). Vegetative cells and cysts of *Margalefidinium polykrikoides* and vegetative cells of *Pyrodinium bahamense* var. *compressum* were found in the samples; both species are historically known for the formation of algal blooms in the central Pacific of Guatemala.

In addition, these samplings were also coordinated with the institutions that make up the National Commission of Red Tide in Guatemala for the collection of bivalve molluscs for the quantification of saxitoxin (STX) through the official method 959.08.16 AOAC (mouse bioassay), at the National Health Laboratory, through the cooperation of the Directorate of Fisheries and Aquaculture Regulations of the Ministry of Agriculture, Livestock and Food (MAGA).
Due to the COVID-19 pandemic, constant sampling was not carried out during 2020.

II. Capacity development

The following conferences, congresses, workshops, and courses were organized and participated in:

- Participation in the III Inland Waters Congress of the Americas. July 5-6, 2021.
- Participation in the Workshop: Restoration of lakes, reservoirs, and rivers. And Methodology for the restoration of riparian ecosystems. July 7, 2021.
- Participation in the 75th Annual Meeting of the Phycological Society of America. July 13-15-20 and 22, 2021.
- Virtual Regional Workshop on Biofouling and Aquatic Invasive Species Management. This workshop is part of the GloFouling Partnerships Project, led by the International Maritime Organization (IMO). August 17, 2021.
- Presenting author at the XIX International Conference on Harmful Algae (ICHA) of the International Society for the Study of Harmful Algae. October 11-15, 2021. Mexico.
- Event organizer: Zooplankton Workshop-Course. Marine Biology Commission + University of Davis California + Plankton Project and Scripps Institution of Oceanography at UC San Diego. Venue: Colegio de Profesionales de Guatemala. August 25-26, 2022. Funding: Academics Without Borders USA (AWB USA) Davis, California.
- Presenting author at the National Marine-Coastal Congress of Guatemala. Title of the contribution: Red Tide in Guatemala. Venue: 28 October 25-28, 2022. Guatemala City.
- Contribution at the Mexican Congress on Harmful Algal Blooms. Title of the contribution: HABs in the Central Pacific of Guatemala. October 3-7, 2022. Mexico.
- Presenting author at the Naval School of Guatemala. Title of the contribution: Importance of Plankton Monitoring in Guatemala. October 18, 2022. Naval School, Guatemalan Pacific.
- Contribution in the Seminar of doctoral students of the PhD in Agricultural and Environmental Sciences of the University of Santiago de Compostela, Spain. Name of the contribution: Toxic microalgae in the Guatemalan Pacific. Directors: Dr Fernando Cobo (USC-Spain) and Dr Yuri Okolodkov (Universidad Veracruzana, Mexico). Virtual event, June 9, 2022.

III. Products generated

Informative article:
Phycological newsletter. Summer/Fall 2020. Volume 56, Number 2 October 9, 2020. Page 18. Topic: Current Status of the Study of Harmful Algal Blooms in Guatemala. https://static1.squarespace.com/static/543d47aee4b0f40897fde705/t/5f80f5fef3350a0e2624b92f/1602287115775/56.2.pdf

Publication in the online platform of REMARCO:
Red de Investigación de Estresores Marinos - Costeros en Latinoamérica y el Caribe. Article: Harmful algal blooms produced by Pyrodinium bahamense in the Guatemalan Pacific.https://remarco.org/blog/2022/05/30/florecimientos-algales-nocivos-producidos-porpyrodinium-bahamense-en-el-pacifico-de-guatemala/

Publication of congress abstract:
Paz-Cordón, Karla Evelyn, Okolodkov, Yuri B., Cobo-Gradín, Fernando, Ortíz-Aldana, José Roberto, Martínez-Dubón, Rebecca Magali. Harmful algal blooms along central Guatemalan Pacific coast In: Band-Schmidt, C.J. and Rodríguez-Gómez, C.F. (Eds.). 2022. Proceedings of the 19th International Conference on Harmful Algae, La Paz, B.C.S., Mexico. International Society for the Study of Harmful Algal Blooms. 365 pp, https://doi.org/10.5281/zenodo.7032902
https://zenodo.org/badge/DOI/10.5281/zenodo.7032902.svg

Articles submitted to scientific journals:
Harmful blooms caused by dinoflagellates in the Pacific of Guatemala (2019-2022).

Species composition and abundance of phytoplankton, with an emphasis on potentially harmful species in the Guatemalan Pacific.

In Project:
Photographic guide to identify plankton-forming species in the Guatemalan Pacific. To be socialized in January 2024.

Informative material:
Posters for social networks and for printing. Technical support in the 2022 emergency during the saxitoxin poisoning in the Guatemalan Pacific.

IV. Relationship with other work groups

- CEMA Liaison to the Regional Project. "Strengthening capacities in marine and coastal environments using nuclear and isotopic techniques" ARCAL RLA 7025. On the topic of harmful algal blooms within the Marine-Coastal Stressors Research Network in Latin America and the Caribbean, REMARCO.

- CEMA liaison to the national red tide commission and member of the technical table for emergency response on this topic.
- Coordinator for Guatemala for the project: Carmina Project: Diversity and toxicity of microalgae associated with ciguatera in the Caribbean area. IFREMER - NOAA -OIEA.
- Coordinator of the Plankton Program of the Institute of Hydrobiological Research, Centre of Studies of the Sea and Aquaculture (Instituto de Investigaciones Hidrobiológicas del Centro de Estudios del Mar y Acuicultura, CEMA) USAC.

V. Needs of the group

These are focused on the improvement of monitoring equipment such as:

- Plankton nets
- Sampling bottles
- Kit for chemical analysis of water
- Utermöhl sedimentation chambers
- Inverted microscope

In addition to training on:

- Microalgae identification
- Molecular identification
- Toxin evaluation
- Ciguatera
- Microalgae cultivation
- Outreach to coastal communities

The need for funding and outreach support is mentioned.

VI. Proposal for the UN Ocean Decade

I National Symposium on Ciguatera in Guatemala
Working group with the main actors related to Ciguatera in Guatemala.
Plan for plankton sampling for the Caribbean zone.

Martinique - Presented by Aurelie Boisnoir [1]

1 French Research Institute for the Exploitation of the Sea (Institut Français de Recherche pour l'Exploitation de la Mer | Ifremer) Department of Environment and Resources

I. Progress in Research and Monitoring

The CARMINA (CARibbean MIcro-algae respoNsible for ciguAtera poisoning: diversity, toxicity and toxin production) project co-funded by the French Development Agency (AFD) and Ifremer aims to identify the algae responsible for ciguatera poisoning in the Caribbean basin, as well as the development of protocols for monitoring the species involved in this

poisoning. It will be based on environmental screening by qPCR, toxicity assessment and the characterization of toxin profiles of Gambierdiscus/Fukuyoa/Coolia species occurring in the Caribbean islands, Central and South America.
This project, which today brings together collaborators from 11 countries, will strengthen scientific cooperation between Caribbean states working on toxic microalgae. The CARMINA partner countries were selected according to their geographical position and their involvement in the existing networks of the Intergovernmental Oceanographic Commission (IOC) of UNESCO and the International Atomic Energy Agency (IAEA), two of the agencies already involved in the monitoring of the marine environment and the development of its resources.
End of the project planned for 2026.

II. Capacity development
The launch of the CARMINA project took place in the form of a webinar from May 9 to 11, 2022 over 3 half days.

III. Products generated
Boisnoir, A., Bilien, G., Lemée, R., Chomérat, N., First insights on the diversity of the genus Ostreopsis (Dinophyceae, Gonyaulacales) in Guadeloupe Island, with emphasis on the phylogenetic position of O. heptagona, European Journal of Protistology, 83, 125875, 2023

IV. Relationship with other work groups
Close collaboration with Nicolas Chomérat and Philipp Hess (IREMER France) and collaboration with ANSES (France) and NOAA (USA).

Panama - Presented by Engineer Arnulfo Sánchez [1], Doctor Carlos Seixas [2]

1 Head of Environment at the Maritime Authority of Panama
2 Veraguas Regional University Center; University of Panama

I. Advances in Research and Monitoring: Ongoing Projects

1. **Project Name:** Toxic or Potentially Toxic Dinoflagellates in the Pacific of Panama.
   Responsible party: Dr Carlos Seixas
   Progress Level: Regular monitoring
   Funding Source: University of Panama
   Description: This project aims to strengthen the database of toxic or potentially toxic organisms in the waters of the Pacific of Panama. It is a permanent project that has expanded monitoring zones in the western Pacific area of the country. It has no allocated funds and utilizes available facilities in government institutions related to the environment.

2. **Project Name:** Ciguatera Benthics in the Caribbean of Panama

Responsible party: Dr Carlos Seixas
Progress Level: Regular monitoring
Funding Source: University of Panama
Description: Different members of the group visit ciguatera risk zones in the Caribbean of Panama and analyze samples of algae and other suspended material in search of ciguatera benthics. The area north of the exit of the Panama Canal in the Caribbean is a region that meets the requirements as a ciguatera risk zone, and the material that came from Mexico is being promoted in this area.

3. **Project Name:** Invasive Species and Monitoring of Cyanobacteria in Freshwater Ecosystems.
   Responsible party: Lic. Cecibeth Aparicio
   Progress Level: Regular monitoring
   Funding Source: University of Panama
   Description: This is a new area of work that emerged as part of a monitoring program for a reservoir that supplies water for ship movement through the canal and is a source of drinking water for a significant part of Panama City. There are indicators of water salinization in the lake's waters, with the incidental presence of coastal dinoflagellates and the species Ceratium furcoides, an invasive species of freshwater lakes. Preventive monitoring is conducted at a dozen points on both the Pacific and Caribbean sides of the Canal.

4. **Project Name:** Support System for Governmental Institutions related to the Environment.
   Responsible parties: HAB-Panama, Zedna Ibis Guerra (ARAP), Yessenia González (UMIT)
   Progress Level: Regular support
   Funding Source: From each institution
   Description: The HAB-Panama group supports the Ministry of the Environment and the Panama Aquatic Resources Authority when algal blooms or cases of aquatic organism mortality occur. The group is divided into three sections that cover the eastern, central, and western parts of the Panama Pacific.

5. **Project Name:** Monitoring Pacific Areas where Harmful Algal Blooms are Reported.
   Responsible parties: Dr Kathia Broce and MSc. Ericka Pinzón, Yessenia González, Zedna Ibis Guerra
   Progress Level: Regular monitoring
   Funding Source: Technological University of Panama and CEMCIT, UMIT, ARAP
   Description: The project is developed at various points in the Pacific of Panama and others in the Caribbean. Some physicochemical parameters of water and phytoplankton diversity are evaluated. The presence of toxin-producing species such as Alexandrium

tamaerense, Dinophysis caudata, Dinophysis ovum, and Dinophysis acuminata-ovum-sacculus, as well as other potentially harmful species linked to fish mortality events due to anoxia or hypoxia, has been documented.

6. **Project Name:** Evaluation of the Possibility of Implementing a Monitoring, Contingency, and Mitigation Program in the Event of Harmful Algal Blooms (HABs) and Ciguatera in Chiriquí Province.
   Responsible parties: Eng. Zedna Ibis Guerra and Eng. Gustavo N. Collado
   Progress Level: Evaluation
   Funding Source: Panama Aquatic Resources Authority (ARAP)
   Description: The project is in the exploratory stage and responds to the recommendations of the U.S. Food and Drug Administration (FDA) to certify fishing areas for the assessment of ichthyotoxins and develop a Contingency Plan in the case of reports of contamination by toxins responsible for ciguatera. Consultations were made with Professors Ángel Vega and Carlos Seixas from CCIMBIO-Coiba and Dr Gustavo Arencibia from Cuba.

7. **Project Name:** Creation of a unit for the identification and characterization of marine toxins and molecular taxonomy of species associated with blooms.
   Responsible party: Mgtr Luis Montero
   Progress Level: Planning
   Funding Source: Facilities at the Center for Medical and Biochemical Sciences Research (CICIMEB), Faculty of Medicine, Autonomous University of Chiriquí
   Description: In Panama, there are no laboratories specializing in the detection of marine toxins, nor specialized laboratories for the molecular identification of species along the coasts of Panama. However, two current situations highlight the need to promote this project as part of the HAB-Panama group. One is the U.S. Food and Drug Administration's recommendation to require companies exporting seafood products to the United States to provide certification of fishing areas for the presence of ichthyotoxins and a contingency plan in case of reports of contamination by toxins responsible for ciguatera. The other favorable circumstance is the recent creation of the Center for Medical and Biochemical Sciences Research (CICIMEB) at the Faculty of Medicine, Autonomous University of Chiriquí. This center has the space, specialists, and support staff for the creation of a Marine Toxins Unit that provides services to countries in the region.
   It is worth noting that this center not only has researchers in the field of chemistry but also a wide range of specialist doctors with whom we could conduct joint research to also focus on health and have a greater impact on the population. It is an ambitious project that costs around $500,000 and will allow for the scanning of toxin profiles in their different classifications (DSP, PSP, ASP, CFP, NSP, and others) and congeners.

II. Capacity Development

Trainings received (R) or imparted (I) by group members

TRAINING NAME	PLACE	DURATION	FUNDING
Taxonomy of continental diatoms	Online (R)	1 month (2021)	Private
International Course on Harmful Dinoflagellates	Online (R)	1 month (2021)	Private
Taxonomy and bioindicators in continental diatoms	Online (R)	1 month (2022)	Private
Course on benthic dinoflagellates	Online (R)	1 month (2022)	Private
Taxonomy and ecology of continental dinoflagellates	Online (R)	1 month (2023)	Private
Course: "Biochemical Pathways of Intoxications by Marine Biotoxins"	Face-to-face (I)	1 semester	UNACHI

III. Generated Products

Reports: 13
Theses: 4
Publications: 2

IV. Collaborative Work

- Logistic support: INNOCEANA, Costa Rica (Red Tides), ARAP, Ministry of the Environment, UMIT, UNACHI, Technological University of Panama, University of Panama.
- Consulting: ANCA-IOCARIBE (Cuba)
- Logistic support: Panama Canal, Panama

V. Group Needs

1. Training and internships needs (for new prospects).
2. Training needs for HAB-Panama group members.
3. Opportunities for collaborative work with ANCA-IOCARIBE.
4. Update seminars through the ANCA network.

VI. Proposal for the UN Ocean Decade

1. Training and awareness workshops on the issues facing the ocean and how we can help.
2. Improvement of legislation to control discharges into the ocean.

Venezuela - Presented by Lorelys Valerio González [1] and Soraya Silva [2].

1 School of Applied Marine Sciences. Universidad de Oriente.

2 Center for Oceanology and Antarctic Studies of the Venezuelan Institute of Scientific Research (IVIC), an entity attached to the Ministry of Popular Power for Science and Technology.

The Bolivarian Republic of Venezuela has an aquatic area of approximately 630,620 km^2 , characterized by a great diversity of natural resources, including the coastal landscape with 4,989 km of coastline, including beaches, islands, islets, lagoons, bays, and marshes. Venezuela is a member of the Harmful Algae of the Caribbean (ANCA) group, which belongs to the IOCARIBE-IOC program. It is also a member of the IOC-UNESCO Intergovernmental Panel on Harmful Algal Blooms. The country has the responsibility to cooperate with Caribbean countries in order to exchange information related to Harmful Algal Blooms, the occurrence of intoxications caused by the consumption of seafood, as well as sharing experiences of national protocols for the management of HABs. Currently, the School of Applied Marine Sciences, Universidad de Oriente (ECAM- UDO) and the Center for Oceanology and Antarctic Studies of the Venezuelan Institute for Scientific Research (IVIC), an entity attached to the Ministry of Popular Power for Science and Technology, are joining efforts in the monitoring of harmful algal blooms in the country. The following are the advances that Venezuela has made in the last two years in relation to the study of HABs.

I. Advances in Research and Monitoring

National Projects

1. Name of the project: National Project 9027: Spatial and temporal study of the state of eutrophication in the coastal zone of interest in the state of Miranda, Venezuela.
Objective: To evaluate temporally and spatially the state of eutrophication in coastal zones of interest in the state of Miranda, Venezuela.
Level of progress: In the initial phase.
Funding source: National Fund for Science, Technology, and Innovation (FONACIT).

2. Project name: Spatial and temporal study of marine environmental stressors at sites of interest on the central coast of Venezuela.
Objective: Generate valuable scientific knowledge on the spatial and temporal variation of four important marine stressors (ocean acidification, harmful algal blooms, eutrophication and microplastic contamination) in sites of socio-economic interest on the central coast of Venezuela.
Level of progress: 50%.
Funding source: National Fund for Science, Technology and Innovation (FONACIT), National Institute of Aquatic Spaces (INEA), Venezuelan Institute of Scientific Research (IVIC), Institute of Earth Sciences, Central University of Venezuela (ICT- UCV).

Cooperation in international projects:

1. Project name: Regional project RLA-7025: *Capacity building in coastal marine environments using nuclear and isotopic techniques (2020-2023)*. Within the framework of this project, monitoring was initiated in Venezuela in the Roques Archipelago, and the Miranda and La Guaira coasts.

Objective: Contribute to the conservation and sustainable management of oceans, seas, and marine resources.

Level of progress: 80%.

Funding source: International Atomic Energy Agency (IAEA).

2. Project name: RLA-7026: *Evaluation of organic and inorganic pollution in aquatic ecosystems in Latin America and the Caribbean and its impact on the proliferation of toxin-producing cyanobacteria that affect human health* (ARCAL CLXXVIII) (2022-2025).

Objective: Strengthen governance and sustainable management of rivers, lakes, and reservoirs in Latin America.

Level of progress: 40%.

Funding source: International Atomic Energy Agency (IAEA).

II. Capacity development

Courses:

1. Name: Techniques for the sampling and identification of benthic microalgae (Facilitator: Lorelys Valerio).
   Place and date: Virtual, July 6-8, 2021.
   Funding source: Fitoland Perú.
2. Name: Marine Dinoflagellates with emphasis on toxic and harmful epibenthic species (Facilitator: Lorelys Valerio).
   Place and date: Virtual, December 17-19, 2021
   Funding source: Fitoland Perú.
3. Name: Use and entry of information in the Harmful Algae Information System and its Harmful Algal Events Database (HAIS-HAEDAT).
   Place and date: Virtual, November 22, 23 and December 6, 2021.
   Funding source: Organized by the IOC ANCA-IOCARIBE regional HAB group.
4. Name: Training course Identification of Harmful Microalgae.
   Place and date: University of Copenhagen, Denmark. August-October 2023.
   Funding source: (RLA 7025) International Atomic Energy Agency (IAEA).
5. Name: Theoretical and practical course on phytoplankton, algal blooms and phycotoxins.
   Place and date: UNAM, Mazatlán, Mexico (Virtual). January 16-27, 2023.
   Funding source: UNAM.

Congresses:

1. Authors: Valerio-González Lorelys, López- Monroy Fabiola, Morales- Benavides Dilcia, Troccoli-Ghinaglia Luis.
   Name of the work: Distribution of potentially toxic epibenthic dinoflagellates in Venezuela.
   Event: XIX International Conference on Harmful Algae.
   Place and date: Virtual. La Paz, Baja California Sur, Mexico. October 15, 2021.

Workshops:

1. Name: Regional Workshop on the index of coastal eutrophication potential (ICEP) and harmful algal blooms (HABs).
   Place and date: Trinidad and Tobago (Virtual). July 25-26, 2022.
   Duration: 8 hours.

Meetings:

1. Name: CARMINA project cooperation proposal.
   Place and date: Virtual. May, 2022
   Funding source: IFREMER.
2. Name: IX Meeting of the ANCA IOCARIBE group. Advances and proposals by Caribbean countries on the study of harmful algal blooms.
   Place and date: Virtual. September 12, 2023.
   Funding source: ANCA/ IOCARIBE.
3. Name: XVI Session of the IOC-FAO-Intergovernmental Panel on Harmful Algal Blooms (IPHAB).
   Place and date: Rome, Italy. March 27-29, 2023.
   Funding source: IOC-FAO.

III. Products generated

Scientific articles:

Mafra L., Sunesen I., Pires E., Mattos S., Álvarez G., Mancera-Pineda J., Torres G., Carnicer O., Huamaní J., Sánchez S., Martínez-Goicoechea A., Morales-Benavides D. and Valerio-González L. 2023. Benthic harmful microalgae and their impacts in South America. Harmful Algae: 102478.

Reports obtained:

Terán M., Lunar J. and Morales D. 2023. Report on the white turbid around Coche Island, Villalba municipality, Nueva Esparta state. Technical report of the Centro Nacional de Investigación de Pesca y Acuicultura (CENIPA).pp. 4.

Thesis (Promotion work):

Valerio, L. (2021). Marine biotoxins and their physiological effects. Promotion work presented as a partial requirement for promotion to the rank of associate professor. Pp. 45.

IV. Relations with other working groups

Some virtual meetings have been held with CENIPA officials, to discuss issues related to reports of algal blooms in the country and to make the HAEDAT database known.

Additionally, alliances have been established with other regional and national institutions, such as: REMARCO, INEA, Ministry of Fisheries and Aquaculture, UCV, Fundación Ecológica Ecobrión, Miranda in order to address algal blooms more efficiently.

V. Group Needs

As a country, one of the greatest needs is capacity building in morphological and molecular identification, toxin analysis and acquisition of inputs for toxin analysis. As well as the maintenance of some laboratory equipment.

VI. Proposal for the UN Ocean Decade

Venezuela coordinates a regional project endorsed by the Decade and affiliated to the Marine Life 2023 program: "TAC Pollutants Observatory". Specific actions could be proposed within the framework of this project.

Mexico - Presented by José Luis Peña Manjarrez [1]

1 SEP-D GECyTM-CETMAR Ensenada
HARMFUL ALGAE GROUP OF THE CARIBBEAN AND ADJACENT AREAS (ANCA IOCARIBE)

I. Advances in Research and Monitoring

Projects in development: In topics related to dinoflagellates, chemical ecology, and molecular ecology of dinoflagellates, among others.

- **Project Name:** Addressing the issues associated with harmful algal blooms in Baja California: integrating knowledge into socio-environmental and economic needs.
- National Strategic Program in Socioecological Systems and Sustainability of CONAHCYT.
- National Research and Advocacy Project (PRONAII)

Responsible party: Ernesto García Mendoza
Funding Source: CONACyT-PRONAII, PRONACES SSyS 319104 project.
Level of Progress: The project officially launched the Harmful Algal Blooms Early Warning System (SiAT-FAN).

Completed Projects in Oaxaca:

1. Evaluation of eutrophication and proliferations in Laguna La Pastoría: causes and consequences (PRODEP-CA-39-32077).
2. The role of the mixture of different types of water in the change of the microbial community: case of Laguna La Pastoría. CUP UMAR: 2IR2103.

Monitoring Progress:

Events that required actions by COFEPRIS from 2021 to November 2023.

- Approximately 4,080 days of Sanitary Closure,
- Duration from one to 181 days,
- 93 events caused by: PSP-9; DSP-8; ASP-1; NSP-29, Undetermined Causes-46

1. Geographic area: Bahia de Todos Santos, Baja California.
Reported novelty:
March-June 2020: *Lingulodinium polyedra / Noctiiluca scintillans*
March-April 2022: *Lingulodinium polyedra*
April-May 2023: *Pseudo-nitzschia australis*

2. Geographic area: Laguna La Pastoría, Villa de Tututepec, Oaxaca, Mexico.
Reported novelty: Eutrophication and proliferations
June 2021: 1.5 and 8.4 x 10^6 cells/L.
June 27 - September 28, 2022

3. Geographic area: San Felipe-Puertecitos
Reported novelty: Sanitary emergencies caused by *Gymnodinium catenatum*
September 6 - November 8, 2023

4. Geographic area: Upper Gulf of California
Reported novelty: Sanitary emergencies caused by *Gymnodinium catenatum*
August 2 - September 20, 2023

5. Geographic area: Bahía Altata-Ensenada Pabellones
Reported novelty: Sanitary emergencies caused by *Gymnodinium catenatum*
July 11 - August 9, 2023

II. Capacity Development
Congress in northern Pacific of Mexico:

1. 19th International Conference on Harmful Algae (ICHA), La Paz, Baja California Sur, Mexico (Virtual), 2021.
2. National Congress of the Society for the Study of Harmful Algal Blooms (SOMEFAN), 2022.
3. VIII Mexican Congress of Ecology. 2022.
4. 20th International Conference on Harmful Algae (ICHA), Hiroshima, Japan, 2023.

Courses

- Introduction to the study of harmful algal blooms, 2020 edition, online

Directed Theses in the Caribbean

- 1 undergraduate.
- 2 master's.
- 1 doctorate.

Directed Theses in the Pacific

- 3 undergraduate.
- 3 master's.

Early Warning System (EWS)

It integrates monitoring, prediction, and risk communication actions before the appearance of a HAB. It also seeks to recognize an HAB at an early stage of development. In this sense, the EWS has inputs from which final products will be generated to address the problem caused by the accumulation of species with potential for harm and/or their transport to impact zones. These inputs are oceanographic conditions, meteorological conditions, biological variables, and the results of prediction models, which will result in:

- Distribution maps.
- Information bulletins.
- Real-time data.
- Trend graphs.
- Prediction and analysis of trends.
- Risk indicators.

III. Generated Products

Outreach related to Baja California Sur

1. "Environmental Crisis and Food Poisoning: The Case of Ciguatera". Nexos Magazine. 2021. https://medioambiente.nexos.com.mx/la-crisis-ambiental-y-las-intoxicaciones-alimentarias-el-caso-de-la-ciguatera/
2. Harmful algal blooms ("red tides"): What are they, why are they harmful, and what are they for? Natural Resources and Society, Digital Magazine of Scientific Dissemination. DOI: 10.18846/RENAYSOC2015.01.01.0004.
3. Radio program: "Ciguatera". Scientific dissemination spot

Articles

Gárate-Lizárraga, I., Pérez-Cruz, B., Díaz-Ortiz, J. A., Alarcón-Tacuba, M. A., Alarcón-Romero, M. A., Chávez-Almazán, L. A., ... & Diego-Valderrama, E. (2013). Blooms of Pyrodinium bahamense var. compressum and rock oyster toxicity in Costa Chica, Guerrero, Mexico. CICIMAR Oceánides, 28(1), 37-42.

Publications: 14 for the northern Pacific between 2021-2023

IV. Relationship with other working groups

A HAB monitoring network (REDFAN) has been established with the participation of institutions such as CESAIBC, SEMAR, UABC, CICESE, COEPRIS, Baja Aquafarms, Pacifico Aquaculture, Servax Bleu.

In addition, four sectors have been integrated: academia, government, the productive sector, and civil society, totalling more than 20 organizations or institutions, which collaborate by sharing knowledge, advice, and information for a multi- and interdisciplinary approach to the impacts of HABs. This covers aspects such as basic and applied research on HABs,

surveillance, responses, and regulation in fishing, aquaculture, water production, environmental monitoring, and conservation.

V. Group Needs

VI. Proposal for the UN Ocean Decade

The intense work of the parties involved identified the priorities that guide the efforts and actions of Mexico's Action Plan and Strategies (PAEM) to achieve the goals of the Decade. These are:

1. Combat Marine Pollution.
2. Conserve and Restore Marine Ecosystems and Promote Ocean Culture.
3. Promote a Sustainable Ocean Economy and Manage Marine Resources Responsibly.
4. Improve the Capacity for Monitoring and Predicting Oceanographic Conditions.
5. Implement the 2030 Ocean Security Policy: Early Warning and Community Resilience.
6. Improve Ocean Data Management in Mexico.
7. Dissemination of ancestral scientific knowledge, a strategy that seeks not only to address current problems but also to lay the foundations for a future where oceans play a crucial role in global well-being and sustainable prosperity.

It is considered that after the implementation of the PAEM, Mexico will safeguard its marine ecosystems, ensure the sustainable management of resources, and contribute to global efforts to achieve a healthier and more resilient oceanic environment.

Ciguatera Incidence in Southeast Mexico: Bibliographic Review and Knowledge Dissemination to the Fishing Sector (MAPFRE Project)

Presented by Thierry Brulé [1] - Researcher

[1] *Merida Unit of the Center for Research and Advanced Studies (CINVESTAV), Department of Marine Resources, Head of the Ichthyology Laboratory*

This project aims to track and analyze cases of ciguatera poisoning in Yucatan and Quintana Roo and disseminate information in the fishing sector through the organization of interactive workshops.

The proposal was submitted to the MAPFRE Foundation's "Ignacio H. de Larramendi Research Grants," 2023 call, in the area of Health Promotion: Education in emergency maneuvers for the general population.

Ciguatera:

Human food poisoning is caused by the ingestion of fish and shellfish containing biotoxins (e.g., ciguatoxin-1 [CTX]) in their tissues. Toxins are synthesized by marine unicellular

dinoflagellates (e.g., Gambierdiscus and Fukuyoa), which accumulate and transform along the food chain. It is endemic in tropical and subtropical marine environments of the South Pacific, the Indian Ocean, and the western Atlantic, although it has been observed in other parts of the world such as the United States, Canada, Germany, and France, as a result of the international trade of marine products and of international travel. Globally, ciguatera is considered the primary non-bacterial food poisoning caused by fish consumption.
More than 425 species of tropical fish have been recognized as vectors responsible for causing ciguatera in humans. Some examples include Sphyraenidae (barracuda), Carangidae (Seriola, amberjack, pompano), Epinephelidae (grouper, hind), Lutjanidae (snapper), Labridae (parrotfish), Acanthuridae (surgeonfish), Muraenidae (moray eel), Scaridae (parrotfish), Scombridae (mackerel), Balistidae (triggerfish, filefish).

The main symptoms of ciguatera include extreme fatigue and various types of pain, and more than 175 gastrointestinal, cardiovascular, and neurological symptoms. Neurological symptoms appear after gastrointestinal symptoms and include a hypersensitivity to cold known as temperature sensitivity. For their part, cardiac symptoms include bradycardia, tachycardia, and hypertension, which appear between one and three hours after ingesting contaminated fish or shellfish. These symptoms can last for two to three weeks, and intermittent recrudescence of symptoms is sometimes observed over a period of months or years. In the case of children, the pathology is especially severe and can be considered life-threatening.

It is common and well-documented in the Central-Western Atlantic, including Bermuda, the United States (Florida), the Bahamas, the Gulf of Mexico, and the Caribbean Sea. Although the northern Yucatan Peninsula is not well-documented and has little information about it, as mentioned in the Mexico country report, work on this topic has mainly focused on the Mexican Pacific coast.

As a result of this work, dinoflagellates *G. caribaeus, G. carolinianus,* and *G. carpenteri,* responsible for causing ciguatera, have recently been detected towards the Caribbean coast in the northern state of Quintana Roo, similar to the Gulf of Mexico area corresponding to the United States. In addition, the main species of fish involved in ciguatera transmission have been reported along the Mexican coasts of the Gulf of Mexico and the Caribbean Sea, including several commercially important species such as barracudas, groupers, snappers, among others. An important case is the Campeche Bank, which has a large abundance of groupers, with 21 species, and 14 species of snappers, supporting two fishing fleets corresponding to Mexico and Cuba.

Project Justification:

Cases of ciguatera poisoning are currently reported in Mexico, particularly in the southeastern region of the country, and populations in the states of Campeche, Yucatan, and Quintana Roo are unaware of the reality of this disease.

Objectives:

- Conduct a bibliographic search and analysis of available information on cases of ciguatera poisoning in the states of Campeche, Yucatan, and Quintana Roo.
- Organize interactive workshops with various fishing communities in this region to inform them about the origin, diagnosis, and treatment of this disease. (Regarding this point, progress has been made in the Yucatan province where interactive workshops have previously been conducted, mainly with the fishing community).

After the presentation of Mexico, the country reports section of the agenda concluded.

Comments and Final Proposals

Intervention by Lorna Inniss (IOCARIBE): In the next two months, it is necessary for the group to prioritize the consolidation of a proposal/project for the Actions of the Ocean Decade , as this is the path through which resources can be obtained. There are four parts to the call for the **Decade Actions**, with emphasis on two:

Part 1 "Co-design of decade actions ": Call No. 6/2023 is focused on groups from **Africa and the SIDS of the Caribbean**. Its objective is to support training, technical support, and capacity support and co-design a robust idea for the **Decade Actions**. (deadline: December 10, 2023)

Part 3 "Project proposal": 31 programs are requesting projects. It is recommended to link projects under these global programs to ensure that everyone works in the same direction.

Based on this proposal/project, it is possible to give relevance to face-to-face meetings by presenting the added value of inviting sectors such as Health and Fisheries, as this would be the first meeting to include them.

Intervention by Rosalba Alonso (Mexico):

Proposals:

- Resume the Certification Course for the Identification of HABs.
- Propose an annual meeting to input information into HAEDAT.
- Expand the members of ANCA-IOCARIBE.

Intervention by Jose Luis Peña (Mexico): Suggested that the focal point of the proposal for the Ocean Decade should be **Early Warning Systems** in each region.

Intervention by Jose Ernesto Mancera (Colombia): Leaders should be appointed for each of the specific proposals identified by Rosalba to give them direction.

Intervention by Gustavo Arencibia (Cuba): Offered himself to lead the proposal for **Early Warning Systems.**

Intervention by Jose Luis Peña (Mexico): Volunteered to lead a proposal in search of funding.

Intervention by Leonardo Guzmán - Leads a working group on HAB solutions: Focused on encouraging participation in HAB-S (Harmful Algal Bloom Solutions Program) among interested ANCA countries or interaction between ANCA and FANSA or regional groups. Topics addressed: USEPA - HANA - ANCA - FANSA.

The program lacks funding, so resources must come from interested countries or through collaborative international resource acquisition.

The proposal focuses on four main areas:

1. Prevention, control, and mitigation of HAB events.
2. Advances in tools and technologies for observing HABs.
3. Equitable access to data on HABs.
4. Improving literacy related to HABs.

The program is within the framework of the Proposal for the UN Ocean Decade 2021-2030. It also proposes that countries already working on literacy and which have their own funding can join and forge a comprehensive comparative proposal that can be adapted to each country's needs.

Proposals for the In-Person Workshop in Panama:

Intervention by Arnulfo Sánchez (Panama): Proposed Panama as the venue for the next in-person ANCA meeting and commits to seeking private funds to carry it out.

Intervention by Gustavo Arencibia (Cuba): Proposed seeking funding not only for the meeting's realization but also for the attendance of other members. Proposed April 10 as a tentative date for the in-person meeting in Panama.

ANNEXES

Table 1: Participants in the HAB-ANCA-IOCARIBE Meeting

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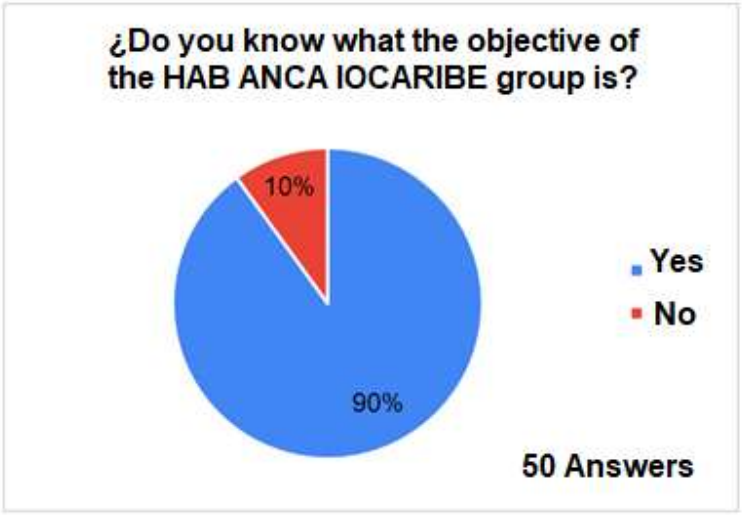
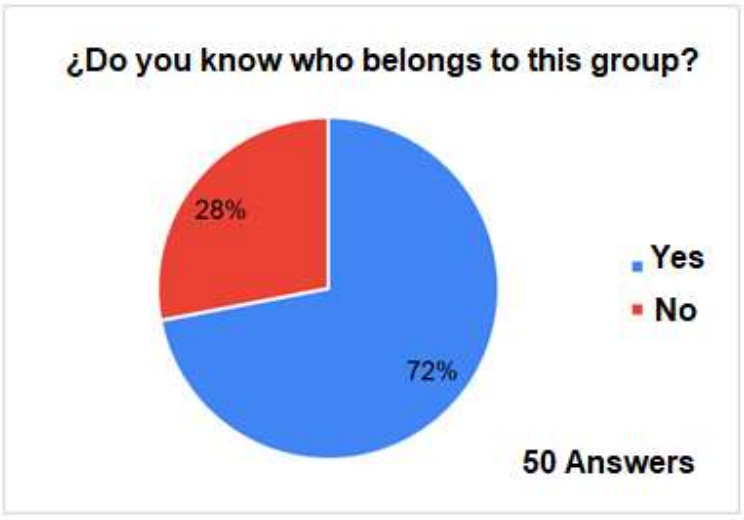
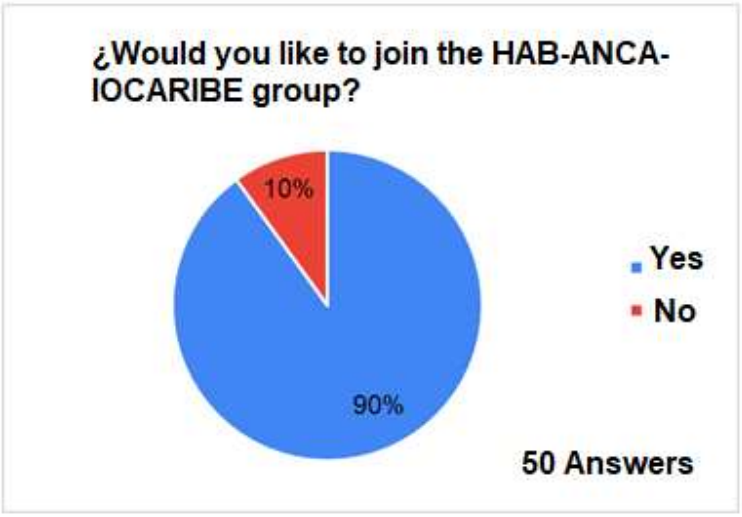
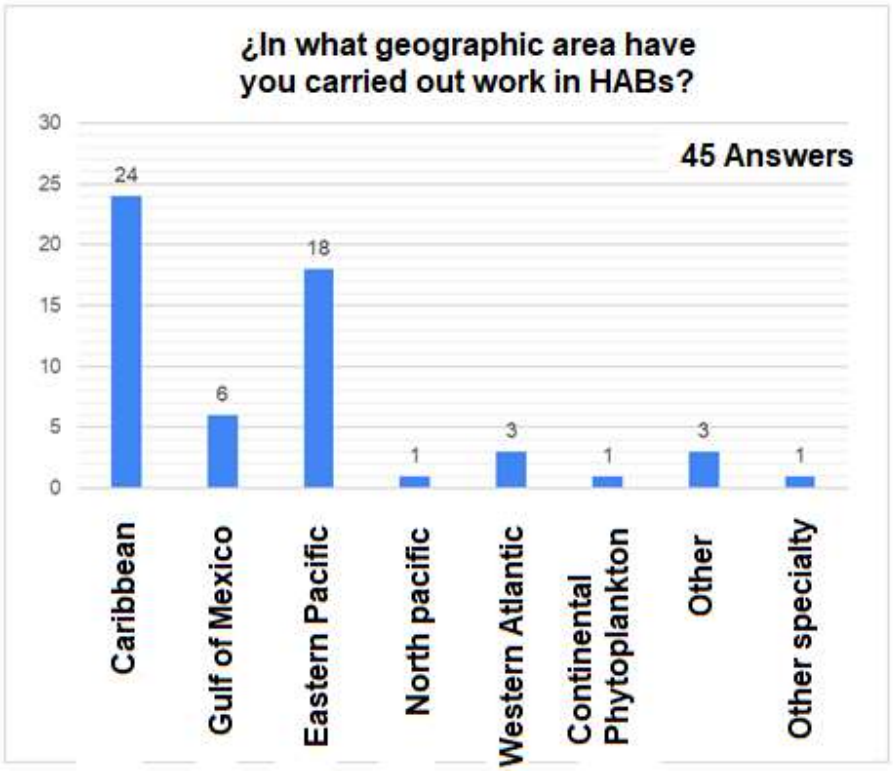
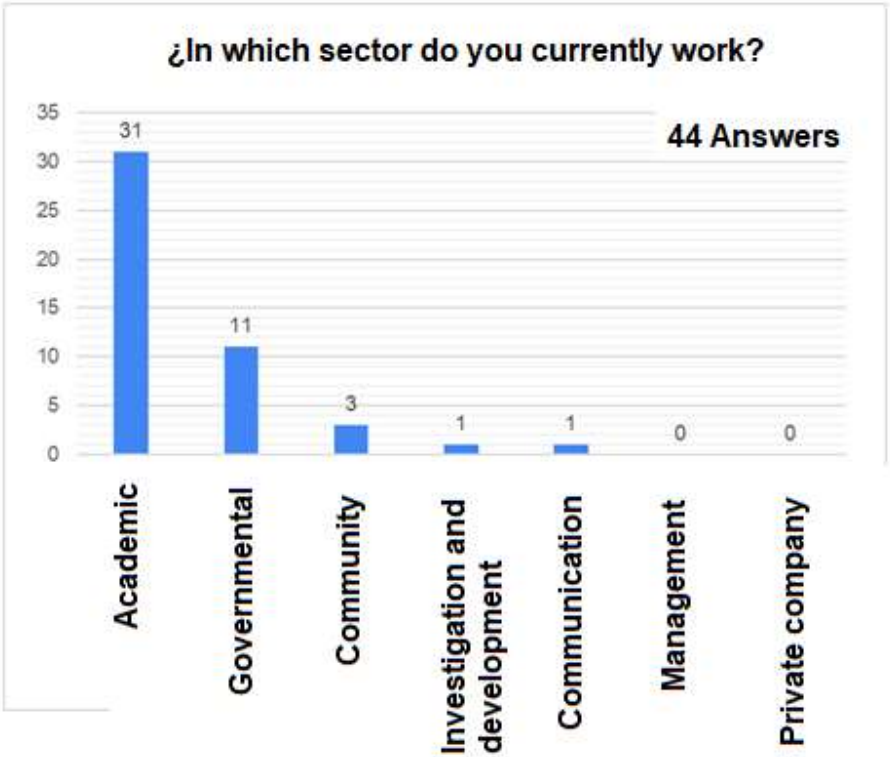
With the purpose of investigating the existing knowledge in the IOCARIBE Region about the HAB-ANCA group, a survey was carried out. The results are as follows:






¿Would you like to join the HAB-ANCA-IOCARIBE group?
10%
90%
Yes
No
50 Answers


¿In what geographic area have you carried out work in HABs?
45 Answers
30
25
20
15
10
5
0
24
6
18
1
3
1
3
1
Caribbean
Gulf of Mexico
Eastern Pacific
North pacific
Western Atlantic
Continental Phytoplankton
Other
Other specialty


¿In which sector do you currently work?
44 Answers
35
30
25
20
15
10
5
0
31
11
3
1
1
0
0
Academic
Governmental
Community
Investigation and development
Communication
Management
Private company