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By Asep Bulkinsi

The digital revolution that is currently happening around the world is also impacting upon Indonesian fisheries, especially in the aquaculture sector. Various digital and technology-based startups have sprung up in the last five years providing digital, AI and IoT-based water quality tools and automatic feeders; financial technology and management investment; and online-based marketplaces for inputs and harvested products. In doing so, they are instrumental in providing solutions to some long-standing problems which make national production less efficient and less competitive. Their presence makes uncertain and high-risk aquaculture more predictable and promising.

**ACHIEVING RESILIENCE AND SUSTAINABILITY IN THE SEAWEED INDUSTRY IN MALAYSIA**

By Phaik-Eem Lim, Sze-Wan Poong, Cicilia S.B. Kambeey, Ji Tan and Amaz Asri

The carrageenophytes Kappaphycus and Eucheuma are carrageenan-producing tropical red seaweeds cultivated on a large scale in Malaysia. Analysis of the carrageenan value chain has shown that the production and export of these seaweeds have declined in recent years. Challenges to the growth of the industry include climate change, inconsistent supply of healthy seedlings, the need for more inclusive governance, the lack of innovation and dedicated research and development (R & D), as well as inadequate farm biosecurity management measures and poor coordination in downstream marketing. Recommendations are provided for the long-term economic development and sustainability of Malaysia’s seaweed aquaculture industry.

**SMALL-SCALE FISHERIES COME INTO FOCUS**

By the Illuminating Hidden Harvests team

Findings from the forthcoming Illuminating Hidden Harvests (IHH) report show that small-scale fisheries produce 37 million tonnes of global catch and employ 90% of those working along the value chain in capture fisheries globally. These findings and others will add to the growing body of evidence around small-scale fisheries and support fisherfolk in achieving a 'seat at the table' in national, regional and global policy processes.

**FRESHWATER EEL INDUSTRY PRACTICES IN THE PHILIPPINES**

By Francisco F Santos, Jerwin G Baure, Mary Nia M Santos, and Lilian C Garcia

Eel farming, which contributes over 90% of all Anguilla production worldwide, is dependent on growing out wild-caught juvenile (or glass) eels. While the culture and trade of temperate Anguilla species is well-established, less is known about tropical species. This article is based on a study conducted by the authors, the findings of which have been compiled in a manual entitled “Freshwater Eel Culture Industry Practices in the Philippines”. This is the first such manual to document and present the different culture systems, industry practices, and problems associated with the country’s eel farming sector.

**A MOMENT FOR INDONESIAN AQUACULTURE TO ACCELERATE COMPETITIVENESS THROUGH THE PRESENCE OF STARTUPS**

By Asep Bulkinsi

**HOW MANDATORY TESTING OF BALLAST WATER MANAGEMENT SYSTEMS PROTECTS FISHERIES AND AQUACULTURE**

By Ersi Zacharopoulou, Lisa Drake, and Guillaume Drillet

Invasive species can cause irreversible damage to both marine biodiversity and industries such as fisheries and aquaculture which depend on a clean environment. As one source of pathogens is the ballast water that is discharged from ships, it is crucial for regulatory authorities and industry stakeholders to ensure that vessels are in compliance with the International Convention for the Control and Management of Ships’ Ballast Water and Sediments, 2004 (BWM Convention), which entered into force globally on 8 September 2017. This article calls for mandatory testing of the ballast treatment management systems (BWMS) installed in ships to verify their efficacy in preventing harmful species from being introduced.

**INDUSTRY PROFILE**

Professor Alan Reilly

Adjunct Professor at the Institute of Food and Health, University College Dublin, Ireland; Adjunct Professor at the School of Food Science and Environmental Health, Technological University, Dublin; Chairman of the Scientific Advisory Board of the European Food Information Council

**EVENTS**

The 6th INFOFISH World Shrimp Conference and Trade Exhibition (Press release)

The 17th INFOFISH World Tuna Trade Conference and Exhibition (Press release)

Marine Fin Fish Hatchery Operations, Grow-out Farming and Health Management (Virtual Training)

**FISHBYTES**

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The International Year of Artisanal Fisheries and Aquaculture 2022 (IYFA 2022) continues to be celebrated in this issue of the INFOFISH International. A major challenge is that while small-scale fisheries and aquaculture play an irreplaceable role in ensuring food security and sustaining livelihoods of people throughout the world, there remain gaps in the substantive data needed to inform development policies. It is therefore timely that this year will see the publication of a report on a seminal study called Illuminating Hidden Harvests (IHH) which will help to shine a much needed light on global small-scale fisheries. While we wait for the full report to be unveiled, an article containing a summary of its key findings is included in this issue as an appetiser.

Still on the subject of the small-scale sector is an article on seaweed culture in Malaysia, where the cultivation of carrageenophytes plays a very important socioeconomic role by supporting the livelihoods of remote coastal communities in the country. In an article on this subject, researchers in Malaysia report on the key gaps linked to a decline in seaweed production over past years, and propose specific measures to invigorate the local seaweed industry. Among these measures is the need for innovation at all stages of the industry.

Picking up on the theme of innovation, another article features startups in Indonesia, a powerhouse in the region for fisheries and aquaculture. The author writes about the increasing presence and influence of home-grown digital and technology-based startups providing digital, AI and IoT-based tools; financial technology and management investment; and online-based marketplaces for products. More importantly, these startups place farmers at the centre of development, providing benefits for them as users and also for companies as technology providers.

Moving on to the Philippines, another country with a strong fisheries and aquaculture industry. This time the focus is freshwater tropical eel, a species which has become an important export commodity for the country. This article is based on a study conducted by the authors, the findings of which have been compiled in a manual entitled "Freshwater Eel Culture Industry Practices in the Philippines". This is the first such manual to document and present the different culture systems, industry practices, and problems associated with the country’s eel farming sector.

Stepping away from production and marketing considerations, we have included an article relating to an issue which needs more global awareness and action; i.e. the introduction of invasive organisms through the discharge of ballast water from ships. The authors highlight the importance of mandatory testing of the ballast treatment management systems (BWMS) installed in ships, and call for regulatory authorities and industry stakeholders to ensure that vessels are in compliance with the International Convention for the Control and Management of Ships’ Ballast Water and Sediments, 2004 (BWM Convention).

And continuing our well-received series of interviews of prominent persons in the industry, in this issue we are privileged to feature one of the foremost experts in the field of fish fraud, Professor Alan Reilly. In addition to presenting clear explanations on fraudulent practices, Prof Reilly takes us on a journey of the chain of events which led to the strengthening of food fraud detection policies as well as presents an update of the relevant frameworks which would help food regulators to “stay one step ahead of the criminals”.

In addition to the articles and interview mentioned above, we invite you to read through the rest of the magazine, the contents of which are intended to provide a holistic view of the global fisheries industry – such as industry notes, marketing information, as well as notes on innovations and equipment.

Last but not least, we draw your attention to two huge global conferences that we are organising this year: The 6th World Shrimp Trade Conference & Exhibition (virtual) confirmed for 8-10 June and our well-known flagship event, the 17th INFOFISH World Tuna Trade Conference & Exhibition which will be held on 11-13 October. Details of both these events, and all the reasons why you should save the dates, are contained in this issue.

We wish you happy reading.

Shirlene Maria Anthonysamy
Director, INFOFISH
Resúmenes de los principales artículos

LA PESCA EN PEQUEÑA ESCALA TOMA MÁS PROTAGONISMO ......................................................................................................................... 8
Por el equipo de Illuminating Hidden Harvests

Los hallazgos del informe Illuminating Hidden Harvests (IHH), próximo a publicarse, muestran que las pesquerías a pequeña escala producen 37 millones de toneladas de la captura total global y emplean al 90% de quienes trabajan a lo largo de la cadena de valor en la pesca de captura a nivel mundial. Estos hallazgos y otros se sumarán a las crecientes pruebas acumuladas sobre la pesca en pequeña escala y ayudarán a los pescadores a conseguir un “lugar en la mesa” en los procesos de políticas nacionales, regionales y globales.

ES MOMENTO DE QUE LA ACUICULTURA DE INDONESIA ACELERE LA COMPETITIVIDAD A TRAVÉS DE STARTUPS........ 21
Por Asep Bulkini

La revolución digital que está ocurriendo en todo el mundo también afecta a las pesquerías de Indonesia, especialmente en el sector de la acuicultura. En los últimos cinco años han surgido varias empresas digitales y de tecnología que proporcionan alimentadores automáticos y herramientas digitales de calidad de la agua, basadas en IA e IoT; inversión en gestión y tecnología financiera; y mercados en línea para insumos y productos cosechados. Al hacerlo, son fundamentales para brindar soluciones a algunos problemas de larga data que hacen que la producción nacional sea menos eficiente y menos competitiva. Su presencia busca que la acuicultura incierta y de alto riesgo sea más predecible y prometedora.

CÓMO LAS PRUEBAS OBLIGATORIAS DE LOS SISTEMAS DE GESTIÓN DEL AGUA DE LASTRE PROTEGEN LA PESCA Y LA ACUICULTURA........................................................................................................................................................................ 26
Por Ersi Zacharopoulou, Lisa Drake y Guillaume Drillet

Las especies invasoras pueden causar daños irreversibles tanto a la biodiversidad marina como a las industrias, incluyendo la pesca y la acuicultura, que dependen de un medio ambiente limpio y saludable. Dado que una fuente de patógenos es el agua de lastre que se descarga de los barcos, es fundamental que las autoridades reguladoras y las partes interesadas de la industria se aseguren de que los barcos cumplan con el Convenio internacional para el control y la gestión del agua de lastre y los sedimentos de los buques, 2004 (Convenio BWM), que entró en vigor a nivel mundial el 8 de septiembre de 2017. Este artículo exige pruebas obligatorias de los sistemas de gestión del agua de lastre (BWM) instalados en los barcos para verificar su eficacia en la prevención de la introducción de especies nocivas.

EN BUSCA DE RESILIENCIA Y SOSTENIBILIDAD EN LA INDUSTRIA DE LAS ALGAS MARINAS EN MALASIA.................. 47
Por Phaik-Eem Lim, Sze-Wan Poong, Cicilia S.B. Kambey, Ji Tan y Azam Asri

Las carragenófitas Kappaphycus y Eucheuma son algas rojas tropicales productoras de carragenina que se cultivan a gran escala en Malasia. El análisis de la cadena de valor de la carragenina ha demostrado que la producción y exportación de estas algas cayó en los últimos años. Los desafíos para el crecimiento de la industria incluyen el cambio climático, el suministro inconsistente de larvas saludables, la necesidad de una gobernanza más inclusiva, la falta de innovación e investigación y desarrollo (I+D) dedicados, así como medidas inadecuadas de gestión de bioseguridad acuícola y mala coordinación en el marketing descendente. El artículo brinda recomendaciones para el desarrollo económico a largo plazo y la sostenibilidad de la industria acuícola de algas marinas de Malasia.

PRÁCTICAS DE LA INDUSTRIA DE LA ANGUILA DE AGUA DULCE EN FILIPINAS......................................................... 52
Por Francisco F Santos, Jerwin G Baure, Mary Nia M Santos y Lilian C García

La acuicultura de anguila, que aporta más del 90% de toda la producción de la especie en todo el mundo, depende del cultivo de anguiles juveniles (o anguiles de cristal) capturadas en el medio silvestre. Si bien el cultivo y comercio de especies de anguila de agua templada están bien establecidos, se sabe menos sobre las especies tropicales. Este artículo se basa en un estudio realizado por los autores, cuyos resultados se recopilaron en un manual titulado “Prácticas de la industria del cultivo de anguila de agua dulce en Filipinas”. Este es el primer manual de este tipo que documenta y presenta los diferentes sistemas de cultivo, prácticas industriales y problemas asociados con el sector del cultivo de anguila del país.
Résumés des articles de fond

LES PÊCHES ARTISANALES EN LIGNE DE MIRE....................................................................................................................8
Par l’équipe de l’initiative "mettre en Exergue les Captures Cachées"

Les conclusions du prochain rapport sur la mise en Exergue des Captures Cachées (IHH) montrent que les pêches artisanales produisent 37 millions de tonnes au niveau mondial et emploient 90 % des personnes travaillant le long de la chaîne de valeur des pêches de capture. Ces conclusions et d’autres viendront s’ajouter au nombre croissant de preuves concernant les pêches artisanales et aideront les pêcheurs à obtenir un ‘siège à la table de décision’ dans les processus politiques nationaux, régionaux et mondiaux. Suggérée par la Task Force de l’AMAF.

C’EST LE MOMENT POUR L’AQUACULTURE INDONÉSIENNE D’ACCÉLÉRER SA
COMPÉTITIVITÉ PAR LA PRÉSENCE DE START-UPS .................................................................21
Par Asep Bulkini

La révolution numérique qui se produit actuellement dans le monde entier a également un impact sur la pêche indonésienne, en particulier dans le secteur de l’aquaculture. Diverses start-ups numériques et technologiques ont vu le jour au cours des cinq dernières années, fournissant des outils sur la qualité de l’eau et des dispositifs d’alimentation automatique numériques, basés sur l’IA et l’IoT, des investissements en technologie et en gestion financière ainsi que des marchés en ligne pour les intrants et les produits récoltés. Ainsi donc, ils contribuent à apporter des solutions à certains problèmes existants de longue date qui rendaient la production nationale moins efficace et moins compétitive. Leur présence rend l’aquaculture incertaine et à haut risque plus prévisible et plus prometteuse.

COMMENT LE CONTRÔLE OBLIGATOIRE DES SYSTÈMES DE GESTION DES EAUX
DE BALLAST PROTÈGE LA PÊCHE ET L’AQUACULTURE.........................................................................................26
Par Ersi Zacharopoulou, Lisa Drake et Guillaume Drillet

Les espèces envahissantes peuvent causer des dommages irréversibles tant à la biodiversité marine qu’aux industries telles que les pêches et l’aquaculture qui dépendent d’un environnement propre. L’une des sources d’agents pathogènes étant les eaux de ballast rejetées par les navires, il est crucial que les autorités réglementaires et les autorités réglementaires et les intervenants de l’industrie s’assurent que les navires sont conformes à la Convention Internationale pour le Contrôle et la Gestion des Eaux de Ballast et Sédiments des Navires, 2004 (Convention BWM), qui est entrée en vigueur au niveau mondial le 8 septembre 2017. Cet article préconise de tester obligatoirement les systèmes de gestion du traitement des ballasts (BWM) installés sur les navires afin de vérifier leur efficacité à empêcher l’introduction d’espèces nuisibles.

ATTEINDRE LA RÉSILIENCE ET LA DURABILITÉ DANS L’INDUSTRIE DES ALGUES EN MALAISIE........................................47
Par Pary Phaik-Eem Lim, Sze-Wan Poong, Cicilia S.B. Kambey, Ji Tan et Azam Asri

Les carraghénophytes Kappaphycus et Eucheuma sont des algues rouges tropicales productrices de carraghénane cultivées à grande échelle en Malaisie. L’analyse de la chaîne de valeur des carraghénanes a montré que la production et l’exportation de ces algues ont diminué ces dernières années. Les défis à la croissance de l’industrie incluent le changement climatique, l’approvisionnement irrégulier en plants sains, le besoin d’une gouvernance plus inclusive, le manque d’innovation et de recherche et développement (R & D) appropriée, ainsi que des mesures inadéquates de gestion de la biosécurité agricole et une mauvaise coordination dans la commercialisation en aval. Des recommandations sont fournies pour le développement économique et la durabilité à long terme de l’industrie de l’aquaculture des algues marines en Malaisie.

PRATIQUES DE L’INDUSTRIE DE L’ANGUILLE D’EAU DOUCE AUX PHILIPPINES.................................................................52
Par Francisco F Santos, Jerwin G Baure, Mary Nia M Santos et Lilian C Garcia

L’élevage d’anguilles, qui représente plus de 90 % de sa production d’Anguilla mondiale, dépend de la croissance des anguilles juvéniles (ou civettes) de capture sauvage. Si l’élevage et le commerce des espèces d’anguille tempérées sont bien établis, on en sait moins sur les espèces tropicales. Cet article est basé sur une étude menée par les auteurs, dont les résultats ont été compilés dans un manuel intitulé “la Pratique de l’Élevage Industriel d’Anguille en Eau douce aux philippines”. Il s’agit du premier manuel de ce type qui a documenté et présenté les différents systèmes d’élevage, les pratiques industrielles et les problèmes associés au secteur de l’élevage d’anguilles dans le pays.
小型渔业成为焦点

8

By the Illuminating Hidden Harvests team

即将发布的 Illuminating Hidden Harvests (IHH) 报告结果显示，小规模渔业生产了3700 万吨全球渔获量，并雇用了全球捕捞渔业价值链中90%的工作人员。这些发现和其他发现将更加显示出小规模渔业取得的发展，并将支持渔民在国家、区域和全球政策进程中获得“一席之地”。

印度尼西亚水产养殖业通过初创企业提高竞争力

21

By Asep Bulkin

目前在世界各地发生的数字革命也正在影响印度尼西亚的渔业，特别是在水产养殖领域。在过去五年中，各种基于数字和网络的初创公司如雨后春笋般涌现，提供基于数字、人工智能和物联网的水质工具和自动补给器、金融科技与管理投资、添加剂和渔货物的在线市场。在这样做的过程中，初创企业在为长期存在的问题提供解决方案上发挥了作用。这些问题使国家生产效率降低，竞争力降低。初创企业的出现使不确定和高风险的水产养殖更具可预测性和发展前景。

压载水管理系统强制测试如何保护渔业和水产养殖业

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By Ersi Zacharopoulou, Lisa Drake, and Guillaume Drillet

入侵物种会对海洋生物多样性和依赖清洁环境的渔业和水产养殖等行业造成不可逆的损害。由于病原体的一种来源是船舶排放的压载水，因此监管机构和行业利益相关者必须确保船舶符合 2004 年《国际船舶压载水和沉积物控制和管理公约》（BWM 公约），这一公约于2017年9月8日在全球生效。本文呼吁对安装在船舶上的压载处理管理系统（BWM）进行强制性测试，以验证其在防止有害物种引入方面的功效。

实现马来西亚海藻产业恢复和可持续发展

47

By Phaik-Eem Lim, Sze-Wan Poong, Cicilia S.B. Kambey, Ji Tan and Azam Asri

红角叉菜和麒麟藻是在马来西亚大规模种植的产胶热带红藻，对卡拉胶价值链的分析表明，这些海藻的生产和出口近年来有所下降。该行业发展面临的挑战包括气候变化、健苗供应不稳定、需要更具包容性的治理、缺乏创新和专门的研发、农场生物安全管理措施不足和下游营销协调不力。本文为马来西亚海藻养殖业的长期经济发展和可持续性提供了建议。

菲律宾淡水鳗鱼产业实践

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By Francisco F Santos, Jerwin G Baure, Mary Nia M Santos, and Lilian C Garcia

养殖的鳗鱼占全球鳗鱼总产量的90%以上，鳗鱼养殖依赖于野生捕捞的幼鳗（或玻璃鳗）。虽然温带鳗鲡品种的养殖和贸易已经建立，但对热带鳗鲡品种知之甚少。本文基于作者进行的一项研究，研究成果已编入一本名为《菲律宾淡水鳗鱼养殖业实践》的手册。这是第一本记录和介绍与该国鳗鱼养殖业不同养殖系统、行业实践和问题的手册。
خلاصة لأهم المقالات

خلول مصايد الأسماك المحدودة النطاق حيز التركيز

ILLUMINATING HIDDEN HARVESTS

يرجى قراءة مقالة "ILLUMINATING HIDDEN HARVESTS" المكتوبة من قبل فريق بـ "Illuminating Hidden Harvests" يظهر ترتيب تقرير فريق يظهر ترتيب تقرير "Illuminating Hidden Harvests" في المتوسط مصايد الأسماك المحدودة النطاق تنتج 37 مليون طن من المصايد العالمي و توفر 90% من النفايات على طول سلسلة تحميل مصايد الأسماك الطبيعية على مستوى العالم. و تضيف هذه النتائج وغيرها إلى المجموعة المتزايدة من الأدلة حول مصايد الأسماك المحدودة النطاق وتدمج الصواريخ الحصول على "مقدم على الطائرة" ضمن عوامل السياسات المحلية والإقليمية والعالمية.

توجه م ]]ه [[]حذت حلاية في جميع أنحاء العالم أيضاً على مصايد الأسماك الإندونيسية، خاصة في نطاق استزراع الأحياء المائية. وقد طرحت العديد من الشركات الناشئة الرئيسية القائمة على التكنولوجيا خلال السنوات الخمس الماضية لتوفر أليات جودة المياه الرسمية الذكاء الإصطناعي وأنتجت الأحياء المائية المحترفة للتقنية، فضلا عن التكنولوجيا المالية والمستشارين الإداريين والأوامر القائمة على الإنترنت المتكنسة والمنتجات. ويسيرهم بذلك، فينوع الطريق في توفر حلول لبعض المشاكل طويلة الأمد التي تجعل الإنتاج المحلي أقل فعالية وأقل تناسبا. فجودها يجعل أحياء المائية غير المكورة والخليجية الخطيرة أكثر نشاطة للتنمو بها وواحة.

ليف يحمي الاختيار الإجباري لأنظمة إدارة مياه الصابورة مصايد الأسماك واستزراع الأحياء المائية

Phaik-Eem Lim, Sze-Wan Poong, Cieilia S.B. Kambey, Ji Tan و Azam Asri

تتمثل في إجراء اختبارات إجبارية لنظام إدارة مياه الصابورة بتحسينها في منع إدخال الأسماك في مياه الصابورة. وباستخدام نظريات ومعادلات الفكاهة على أساس التكنولوجيا الرقمية، تم إعداد المحاكاة في نظام إدارة مياه الصابورة. وتشمل هذه المحاكاة نشاطاً في الاستزراع الأحياء المائية، استزراع الأحياء المائية، واستزراع الأحياء المائية، وتحقيق القدرة على الصيد والاستكشاف في فضاء استزراع الأسماك في مالزيا.

حقق القدر في الصيد والاستكشاف في فضاء استزراع الأسماك في مالزيا

Phaik-Eem Lim, Sze-Wan Poong, Cieilia S.B. Kambey, Ji Tan و Azam Asri

يتعامل مع التحليلات الرئيسية التي تثبت أن يوجد في مستوى الطبيعة للصيد والاستكشاف الخاصة، وتساعد في تحسين التقنيات في كفاءة ويكون أبحاثاً في تطوير تقنيات القياس، والتحسينات في المنتجات، استنزاف المياه، وتحقيق دراسة في كفاءة استزراع الأسماك، وتحقيق القدرة على الصيد والاستكشاف في فضاء استزراع الأسماك في مالزيا.

سمارس صناعة أنقليس المياه العذبة في الفلبين

Francisco F Santos, Jerwin G Baure, Mary Nia M Santos، Azam Asri

يهدف هذا الهدف الأول من نوعه لتوثيق وعرض أنظمة الاستزراع المختلفة والممارسات الصناعية، فضلا عن المشاكل المرتبطة بقطاع استزراع الأسماك في البلاد.
SMALL-SCALE FISHERIES COME INTO FOCUS

By the Illuminating Hidden Harvests team

Findings from the forthcoming Illuminating Hidden Harvests (IHH) report show that small-scale fisheries produce 37 million tonnes of global catch and employ 90% of those working along the value chain in capture fisheries globally. These findings and others will add to the growing body of evidence around small-scale fisheries and support fisherfolk in achieving a ‘seat at the table’ in national, regional and global policy processes.

“Fishing is as old as humanity. Fish trade is one of the oldest forms of social exchange,” said Toddi Steelman, Stanback Dean of the Nicholas School of the Environment at Duke University. “Yet, their continued invisibility has had important environmental justice and gender inequity implications,” Steelman noted at the Illuminating Hidden Harvests (IHH) key findings webinar on 23 November 2021, which presented some results from the IHH report.

The IHH report is part of a broader initiative led by FAO, Duke University, and WorldFish launched in June 2017 that helps shine a much needed light on small-scale fisheries globally. Due out this year (2022), the report draws on a tapestry of methods, including 58 country and territory case studies, to examine the current environmental, social, economic and governance contributions of marine and inland small-scale fisheries at global and local scales.

Its rationale is that better data on and understanding of small-scale fisheries is needed to enable effective, inclusive and participatory governance and sustainable development of the sector in line with the Voluntary Guidelines for Securing Sustainable Small-Scale Fisheries in the Context of Food Security and Poverty Eradication (SSF Guidelines). Thanks to the contribution of more than 800 experts, new and clearer insights are coming to the surface, adding to the growing body of evidence around small-scale fisheries. This article presents a summary of the key findings from the forthcoming IHH report.

**A first look at key findings**

Small-scale fisheries account for 37 million tonnes (40%) of global catch from marine and inland capture fisheries, which is estimated to be 92 million tonnes. The IHH data finds that 68% comes from marine small-scale fisheries, and 32% comes from inland small-scale fisheries.

Small-scale fisheries catch equates to an average annual total revenue of US$77 billion, based on total revenues from the first sale of the catch. Of this, USD 58 billion and USD 19 billion comes from marine small-scale fisheries and inland small-scale fisheries respectively.

When looking at the economic contributions of small-scale fisheries, the IHH data further finds that 60 million people are directly employed along small-scale fisheries value chains, either part or full time. This represents 90% of all of those employed in capture fisheries along the value chain globally.

An additional 53 million people were engaged in subsistence fishing at least once during 2016. These combined 113 million people have an estimated total additional 379 million household members to support. Therefore, collectively, 492 million people are at least partially dependent on small-scale fisheries. This is equivalent to almost 7% of the world’s population in 2016.

Gender is central to small-scale fisheries and sustainable development, and small-scale fisheries cannot be understood without considering gender. The report finds that at least 45 million women participate in small-scale fisheries value chains worldwide, representing 40% of all estimated small-scale fisheries labour. Women are most engaged in post-harvest, where they account for roughly 50% of the labour in the processing, transporting, trading, and selling of small-scale fisheries catch.

The IHH gender analysis also highlighted several patterns. For example, while women participate in small-scale fisheries in substantial numbers, they are under-represented in governance arenas and face significant barriers to meaningful participation in management and decision-making. Additionally, in many contexts, women, and especially certain groups of women, have less access to small-scale fisheries but stand to disproportionately benefit from them, especially their income and nutrition-related benefits.

The IHH nutrition team was able to identify the recommended nutrient intake (RNI) of some fish for the first time using predictive modelling. This technique revealed that while all fish provide diverse macro- and micronutrients, nutrient values vary substantially among fish types, with small fish being especially nutritious.

Small-scale fisheries catch can play an important role in addressing known nutrition deficiencies, even at the scale

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of national populations. For instance, the total nutrient yield from small-scale fisheries landings could provide 20% of the RNI for the four most abundant nutrients—calcium, selenium, zinc and omega-3 fatty acids, to 137 million women in Africa and 271 million women in Asia.

Finally, to better understand the extent to which co-management has been implemented globally, IHH researchers analysed fisheries policies and the amount of catch governed by those policies for 55% of global small-scale fisheries catch. Results show that at the national level, of every 10 tonnes of small-scale fisheries catch, there are formal co-management provisions for 4 tonnes, but only 2 tonnes are likely co-managed with high participation by fishers, according to IHH country and territory case study experts. These results are mirrored at the subnational level, although the proportion of co-managed catch increases at the local level.

The IHH researchers conducted a global survey of 424 small-scale fisheries producer organisations. Responses showed that 99% of producer organisations have goals related to harvesting and sustainable fisheries management, and 60% have goals related to well-being, including labour rights, food security, or human and environmental health.

Fishers and fishworkers see themselves as active contributors to the implementation of the Voluntary Guidelines for Securing Sustainable Small-scale Fisheries in the Context of Food Security and Poverty Eradication, and not passive recipients of State action.

Improving methods and capacities

The IHH report is an important step to further improve methods and capacities to collect, analyse and use data and information on small-scale fisheries, as a basis for sound and inclusive policy-making and resource governance.

The interdisciplinary approach undertaken by IHH attempts to transcend individual disciplines to integrate different policy domains and sources of information. This methodology, said Manuel Barange, FAO Director of Fisheries and Aquaculture, who spoke at the key findings webinar, will “bring new understandings of the importance of small-scale fisheries.”

Gareth Johnstone, Director General at WorldFish, who also spoke during the key findings webinar, added the need to leverage the robust data and evidence generated from the IHH initiative to advocate for better recognition of small-scale fisheries as crucial to global food systems. This, he underscored, will lead “to healthier and sustainable diets with important small-scale fisheries perspectives on food, nutrition, equity and social justice, and environmental sustainability.”

A communications effort accompanied the IHH study, involving close engagement with key stakeholders to ensure that the key findings and information will be available to those who need them the most. Critically, the IHH results will link with and feed into high-level events, including the UN Decade of Family Farming (2019-2028), the Decade of Ocean Science for Sustainable Development (2021–2030), and the International Year of Artisanal Fisheries and Aquaculture (IYAfA 2022). The latter is being commemorated this year and is an opportunity to highlight the importance of small-scale artisanal fisheries and aquaculture for our food systems, livelihoods, culture and the environment.

The objectives of IYAfA 2022 are:

- Enhance global awareness about, understanding of and action to support the contribution of small-scale artisanal fisheries and aquaculture to sustainable development, and more specifically in relation to food security and nutrition, poverty eradication and the use of natural resources.

- Promote dialogue and collaboration between and among small-scale artisanal fishers, fish farmers, fish workers, governments and other key partners along the value chain, in order to further strengthen their capacity to enhance sustainability in fisheries and aquaculture and to enhance their social development and well-being.

Visit the IHH webpage: https://www.fao.org/voluntary-guidelines-small-scale-fisheries/ihh/en/ to watch the webinar recording or learn more about IHH. Stay tuned for the full report launch in 2022.

The Illuminating Hidden Harvests team comprises resource persons from the Food and Agriculture Organization of the United Nations (FAO), Duke University (USA) and WorldFish.
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Market Trends

**SHRIMP**

**India:** In India, the first crop of the season is expected in March from Andhra Pradesh—the largest *vannamei* producing region of the country, with good forecast in harvests. Local packers are still holding stocks of medium to smaller sizes shell-on shrimp (31/40 to 61/70), in comparison with large sizes (16/20) for which the stocks are low. In view of the upcoming Spring Festival in Japan during April/May, importers may go for last minute procurements from India in February/March. Last year, India was one of the top supply sources of headless and peeled *vannamei* shrimp in Japan. The availability of semi-processed and processed shrimp from Indonesia and raw shrimp from Ecuador has also been good during January-March 2022.

**Vietnam:** As demand for shrimp rose during the Lunar New Year celebrations, prices had also increased. Unfortunately, the increasing infections by the Omicron variant; threats to labour mobility and reduced availability of workers; coupled with increases in processing costs and freight costs impacting the global shrimp market - all this continues to put a strain on Vietnam’s supply capacity. As reported in the Globefish Highlights issue 4/2021, Ecuador and Argentina are now world top exporters of shrimp, aside from India, Indonesia, Vietnam, China and Thailand. Off the back of this, Argentina has also now become one of Japan’s key suppliers.

**South and South East Asia:** Except in Indonesia, farmed shrimp supply generally remains seasonally low in South and South East Asia until March. The first good harvest in other areas in South and South East Asia, is expected in March from Andhra - the largest shrimp aquaculture state in India. The forecasts for harvest in Gujarat, Odisha and West Bengal are also expected to be good from May onwards. The onset of the season in Vietnam, Thailand, Myanmar, and Bangladesh should also commence from April/May. In Ecuador the current good harvest period is likely to continue till the seasonal end this March.

**Japan:** Industry sources in Japan have reported that since 1st February 2022, prices of prepared food will, or are expected to, go up by 4-24 percent, at various levels of the supply chain. This is an anticipated fluctuation, consequent to the increasing prices of gasoline, transportation and other logistic costs. It is anticipated that an increase in prices will impact consumer demand for ready meals. This market effect will be on top of the high infection rate linked with the Omicron virus, which has already reduced sales opportunities in the catering trade during the first two months of this year.

**Argentina/Europe:** In Argentina, land processing of shrimp (produced by smaller boats) is yet to commence, while the factory shrimp fishery closed some weeks ago. Over the Christmas/New Year period, demand was at its usual high, and prices were sky-high, driven by the market in Europe. Argentine shrimp is a particularly popular item for supermarket promotions in Europe, with large Argentine shrimp on offer in some parts at the relatively low price of EUR 10.99/kg (Source: EPR 12/2021). It is anticipated that market prices for shrimp will stabilize into the first quarter of 2022 as supply picks up.

**Europe:** The retail demand for shrimp in Europe during the Christmas holidays remained very high. However, demand from the hotel, catering services and retail (HORECA) sector was limited and below expectations, as the effects of the Omicron variant wave resulted in restrictions affecting restaurant consumption. Even without restrictions, consumer reluctance remains slightly high, with consumers or patrons still relatively fearful of COVID-19 infections. As a result, wholesalers now have large stocks of unsold shrimp. These cold storage holdings, combined with the arrival of land-frozen shrimp from Argentina, have led to price declines (Source: EPR 01/2022).

**USA:** The demand for shrimp has continued to rise despite the higher shipping prices (logistical costs). This has come off the back of a rebound in demand from the HORECA sector. According to some analysts, shoppers now have greater interest in preparing seafood at home due to the pandemic, and in general, Americans have more money to spend on food because of less travel, concerts and movies spending. Consumers are splurging on higher-value seafood meals at home instead, as they become more confident preparing meals-at-home options.

Restaurants and retail stores continue to operate during normal scheduled hours despite the reluctance of consumers to pick up the pace due to the Omicron variant. As expected, shrimp demand decreased as compared to the typical increase during the Christmas and New Year holidays in restaurants and catering services. Demand for shrimp in the retail sector continues to be strong.
Market Barometer

CANNED TUNA

Asia/Pacific and others: Weaker demand for canned tuna persisted in Japan and other markets in Southeast Asia. The only exception was Thailand where imports, mostly consisting of cooked loins for reprocessing, were 4.5 percent higher compared to last year’s corresponding period.

In the large Middle East and North Africa (MENA) region, imports slowed down in Saudi Arabia, Egypt and other large markets, which are generally supplied by Southeast Asian producers. Notably, canned tuna exports from Thailand (the top supplier to the Middle East) increased to Egypt, the United Arab Emirates, Yemen and Algeria during January-June 2021 but declined to Saudi Arabia, Libya, Jordan, Lebanon and some other small markets in the Gulf Cooperation Council (GCC) region (Source: FAO Globefish 04/2021).

PANGASIUS

The volume of pangasius trade has dipped considerably, as restrictions on people’s movements and factory capacity have been introduced in Viet Nam, by far the largest producer and exporter of pangasius. However the overall value of trade has not been as heavily impacted, largely due to increased prices, especially in the United States of America. The disruptions being experienced are likely to have a knock-on effect on supply next year, with the overall situation remaining difficult for farmers and processors alike (Source: FAO Globefish 04/2012).

SALMON

According to FAO-Globefish, as vaccination rollouts continue across the world, demand for salmon from the foodservice sector is returning to supplement revitalized retail channels. Combined with a relatively limited global supply growth, this is pushing prices and revenues upwards, despite widespread logistical challenges.

TILAPIA

USA: Cumulative imports of frozen tilapia were down by 12.8% in volume and 8.6% in value during the third quarter of 2021 as compared to the same period in 2020. Supplies of frozen fillets decreased by 19.6%, while frozen whole tilapia supplies increased by around 13% in volume. Major suppliers of frozen whole tilapia, especially Brazil, recorded a significant increase of exports to the US. However, supplies of frozen fillets were notably down from China and Mexico.

It was noted that sales in the Chinese domestic market for both live and processed tilapia products increased in 2021, which lowered the volume of tilapia exports to the US, particularly frozen fillets. In addition, the decrease in imports of frozen tilapia fillets was due to the increase in imports of high valued species like salmon.

According to FAO Globefish Issue 04/2021, the US tilapia market has been facing some significant challenges such as logistical delays, high freight costs and raw material shortages. Chinese producers have full orders and in some cases cannot meet growing demand, a situation that has been compounded by the shutdown of some factories due to Delta variant outbreaks. In this environment, some suppliers are focusing on the Chinese domestic market, which seems more attractive.
Price Trends

FROZEN SHRIMP, C&F JAPAN (US$/Kg)

FROZEN SHRIMP, WHOLESALe TOKYO, JAPAN (¥ 1000/kg)

FROZEN SHRIMP, cfr USA

FROZEN SHRIMP, USA (ex-warehouse NY, US$/lb)

FROZEN SHRIMP, EUROPE (CFR, US$/kg)

FROZEN TUNA (US$/MT)
Price Trends • Cold storage holdings • import trends

**FROZEN WHITEFISH**

**FISHMEAL/FISHOIL (US$/MT)**

**JAPAN COLD STORAGE HOLDING: SELECTED PRODUCTS (MT)**

**JAPAN COLD STORAGE HOLDINGS TUNAS (MT)**

**JAPAN: MONTHLY IMPORTS OF SHRIMP & TUNA (MT)**

**USA: Monthly SHRIMP Imports**
CEPHALOPODS

Supply problems for octopus; good squid catches

The cancellation of the fishing agreements between the European Union and Morocco will affect supplies of octopus and squid. Octopus supplies from Mexico and Indonesia are also weak. The squid fisheries in the Southwest Atlantic and the East Pacific were strong during the first season; supplies are good and prices are falling.

As at the time of writing, the European Union and Morocco have had fishing and trade agreements for decades, and the present agreement, which will become invalid by December 2021, gives a total of 128 EU vessels access to Moroccan waters (including Western Sahara waters). Consequently, the annulment of the agreements would have serious negative effects on EU fishing in the region, and in particular for the cephalopod landings by EU vessels. The parties are now trying to negotiate a solution.

Octopus

In July and August 2021, European restaurants and foodservice outlets reopened, and demand for octopus immediately surged. The summer holiday season represents a peak in consumption of octopus, and the reopening of the foodservice sector led to strong increasing demand. In Spain, restaurants registered a 20% increase in consumption of octopus compared to the same period in 2020. Supplies have been tight, though. The fishing season in Morocco ended on 5 September, while the season in Mauritania ended in late August. The next fishing season does not open until late December, so the supply situation is not likely to improve. On a positive note, octopus landings in Northern Spain have risen sharply during the summer.

Trade

Chinese imports of frozen octopus during the first five months of 2021 declined to 5 282 tonnes compared to 7 363 tonnes in the same period in 2020. China did not import any octopus from Morocco during this period, and only very modest amounts from Mauritania (86 tonnes in 2021). The largest suppliers during the first five months of 2021 were Pakistan (1 977 tonnes), India (1 185 tonnes) and Indonesia (1 016 tonnes). Imports of octopus (all product forms) into the Republic of Korea during the first half of 2021 increased by 9.1% compared to the same period in 2020, from 32 158 tonnes to 35 088 tonnes. The major suppliers in 2021 were China (15 337 tonnes), Vietnam (13 625 tonnes) and Thailand (3 660 tonnes).

Squid

The first squid season in the Southwest Atlantic closed in June with a good result. The total catch was estimated at 580 000 tonnes, the highest catch since 2015. It was estimated that 280 000 tonnes came from catches on the high seas, 170 000 tonnes in Falkland Islands (Malvinas) waters, and 130 000 tonnes by the Argentine fleet. The second season for loligo fishing started in the Falkland Islands (Malvinas) in August, and the outlook seems to be somewhat better than it was in the first season.
Landings in China’s main squid hub, Zhoushan, increased strongly in 2021. According to the Zhoushan Distant-Water Fishery Port, more than 190 000 tonnes of squid were landed by 214 vessels operating in the Southwest Atlantic and East Pacific, during the first half of 2021. This is a 61% increase compared to the same period in 2020. However, the Ministry of Agriculture announced a moratorium for the Chinese distant-water fleet operating in the Southwest Atlantic from 1 July - 30 September 2021.

**Trade**

Japanese imports of squid and cuttlefish during the first six months of 2021 increased by 6.5% compared to the same period in 2020, from 67 796 tonnes to 72 205 tonnes. China accounts for as much as 61% of this total, with 44 160 tonnes. The second largest supplier is Peru, with 11% of the total import volume.

China’s exports of squid and cuttlefish increased steeply during the first half of 2021 compared to the same period in 2020. Total exports amounted to 247 934 tonnes, up 30.5% compared to 2020. Exports to the largest market, Japan, increased slightly by 3.9%, while exports to the Philippines grew massively by 170%, from 12 058 tonnes to 32 592 tonnes. Exports to Thailand were also up significantly by 19.4% to 32 540 tonnes.

Chinese imports of squid and cuttlefish also increased significantly during the first half of 2021, from 151 427 tonnes in 2020 to 196 261 tonnes in 2021 (+29.6%). The largest supplier, Peru, registered a 122% increase in shipments.

US imports of squid and cuttlefish during the first half of the year increased sharply by almost 43%, to 32 464 tonnes. The largest supplier was China, accounting for 37.4% of the total. India and New Zealand each accounted for about 10% of the total.

The growing demand for cephalopods in Europe is now apparent in import statistics. Spanish imports of squid and cuttlefish were up by 26.6% during the first half of 2021 compared to the same period in 2020. The largest suppliers were the Falkland Islands (Malvinas), Peru, and Morocco.

**Prices**

**Squid: Italy**

![Graph showing squid prices in Italy]

Source: Japan Customs

**Outlook**

Over the coming months, octopus may be in short supply, and this may last until the beginning of 2022, when the fisheries reopen in Morocco and Mauritania. Meanwhile, demand is good and growing, and consequently prices will be going up, too.

The squid fisheries in South America, both in the Southwest Atlantic and in the East Pacific, have been good. Landings in the Falkland Islands (Malvinas), in Argentina, and in the Chinese distantwater port of Zhoushan have been strong, and supplies are therefore quite ample. At the same time, demand is expected to grow, although the summer peak season for consumption is over. Prices have been falling and this trend will likely continue in the next few months.

Source: FAO - Globefish
INFOFISH speaks to …

PROFESSOR ALAN REILLY
Adjunct Professor at the Institute of Food and Health, University College Dublin, Ireland; Adjunct Professor at the School of Food Science and Environmental Health, Technological University Dublin; Chairman of the Scientific Advisory Board of the European Food Information Council; Fellow of the Royal Society of Biology; Fellow of the International Academy of Food Science and Technology (2014-2019); and Fellow of the Institute of Food Science and Technology of Ireland. From 2009 to 2015, he was Chief Executive of the Food Safety Authority of Ireland (FSAI). Prof Reilly is also a former member of the Advisory Forum of the European Food Safety Authority and a former Board Member of the Irish National Accreditation Board.

Setting the stage for the issues that we will be discussing, fishery products are thought to be the third-highest risk category of foods with the potential for fraud. What are the common elements of fraud with regard to fish and fishery products, and what are your estimates of the scale of the problem worldwide?

Seafoods are high-risk products for food fraud and are one of the most frequently traded food commodities in the world. Our highly complex global supply chains can mask seafood fraud, the laundering of catches from illegal fishing and can result in threats to public health, and serious losses in tax revenue. The common elements of fraud include the substitution of high valued species or ingredients with products of lower value or quality; fraudulent enhancements where unapproved or harmful ingredients are added to mask defects or to falsely enhance some sensory or nutritional property of a product; undeclared use of approved additives such as polyphosphates to increase the water content of products; and mislabelling to falsely identify the origin/provenance of products or to cover up illegally captured or slaughtered species, or to falsely declare the method of production.

The scale of the problem is widespread with about one third of fishery products in the seafood chain being mislabelled in some countries. The costs to legitimate businesses in the global economy are difficult to estimate because most incidences of fraud occur below the radar and are never detected. However, the cost of fraud to the global food industry has been estimated at around US$34 billion annually and the cost of illicit trade in marine fish catch to be in the region of US$26 to US$50 billion.

Greed probably ranks as the top reason for fish fraud, but what are other common drivers?

Fraud occurs when seafood is illegally placed on the market with the intention of deceiving the consumer, usually for financial gain. The common ingredients of food fraud are deliberate misrepresentation, gaining economic advantage and intentional deception. Food chains both at national and international level are becoming increasingly complex and therefore more vulnerable to fraud. A common driver of fraud is the desire by criminals to place illegally captured fish on the market which undermines legitimate food business operators and the sustainability of fish stocks. Weak national food controls and inadequate enforcement of regulations also contribute to fish fraud. National governments have the responsibility to ensure that only safe, legally caught, responsibly sourced, and honestly labelled seafoods are placed on the market. Fraudsters are encouraged to ply their trade when they know that the risks of being caught are low. Additionally, where financial penalties for violation of regulations are minimal, fraudsters are not dissuaded from illegal practices.
Two years ago in an article that you wrote for the INFOFISH International, you said that the Codex Alimentarius has a role to play in setting Food Fraud Vulnerability Assessment (FFVA) standards. Has there been any progress that you are aware of, and who are the other stakeholders that you think should be involved in this initiative?

The Codex Committee on Food Import and Export Inspection and Certification Systems (CCFICS) has established an Electronic Working Group (EWG) that aims to define the role of Codex in tackling the challenge of food fraud in the context of food safety and fair practices in the food trade. The work of this EWG is ongoing and is focused on developing internationally agreed definitions and conducting a comprehensive analysis of existing relevant Codex texts to avoid overlapping with other Codex general subject or commodity committees. Codex has not yet developed guidelines for conducting a Food Fraud Vulnerability Assessment (FFVA).

Good progress, however, has been made by private industry organisations, such as the IFS (InternationalFeatured Standards) which has developed the IFS Guideline of Product Fraud Mitigation and this includes guidelines for conducting vulnerability assessments and developing food fraud mitigation plans. Standards of other private sector organisations, such as the British Retail Consortium (BRC), require that food business operators shall have "systems in place to minimise the risk of purchasing fraudulent or adulterated food raw materials and to ensure that all product descriptions and claims are legal, accurate and verified". In addition, some of the large seafood companies, such as Thai Union, have developed their own in-house systems for tackling vulnerability assessment and fraud mitigation.

The COVID-19 pandemic has resulted in widespread disruptions to global food chains that have impacted food production, distribution and trade, with widespread closures of restaurants and bars affecting food producers, suppliers, caterers and the tourism sector. Over the past two years, as we learned more about the virus and how it is transmitted from person-to-person, mitigation strategies evolved and were based on the best science available at the time. What is evident is that the virus is not transmitted through food consumption. While it is theoretically possible for the virus to survive on food/food packaging surfaces, all epidemiological evidence to date shows that this is not an important mode of transmission. The most important issue arising from the pandemic for the food industry is that we need to pay more attention to air quality in food production environments. Experience gained throughout the pandemic shows that ventilation, air exchange and filtration are key to protecting food workers and minimising the impact of SARS-CoV-2.

The pandemic saw an exponential surge in e-commerce and online shopping for food, with increased opportunities for food fraud. Additionally, the decrease in food controls and food inspection activities by national competent authorities during the pandemic has increased risks to the consumer. The good news amid all the bad that the pandemic has brought is that the global food supply chain continued to function and has demonstrated resilience in a time of crisis. Most national authorities have reported a decrease in the incidence of foodborne diseases, most likely due to people not eating out and a reduction in international travel. The wider-scale application of significant public health measures to combat the transmission of COVID-19, such as hand-washing, sanitising and disinfecting food contact surfaces and increased emphasis on the use of personal protective equipment (PPE), all have contributed to reducing the incidence of foodborne disease during the past two years.

Of all the happenings in your professional life, would it be correct to say that the most significant was the discovery in 2013 of the large-scale fraudulent addition of horsemeat to beef? To recap, this scandal saw approximately 5% of all processed beef products on the European market adulterated with more than 1% horsemeat, with some product labelled as beef containing 100% horsemeat. Some unscrupulous meat traders were bulking out processing beef with cheaper horsemeat. It was the most serious incident of food fraud on the European market in recent times. As the then-Chief Executive of the Food Safety Authority of Ireland (FSAI), how did you deal with the implications with regard to public health and loss of confidence in regulatory authorities including the FSAI?

When I received the first results of the authenticity survey of beef products on the Irish market that were conducted in late 2012, I initially thought that there was some kind of error or mistake in analytical testing. However, extensive re-testing in accredited food laboratories showed that the results were correct and I immediately realised that we had uncovered serious fraudulent practices. As the primary function of the


This next question is linked to the topical issue of the still ongoing pandemic which has shaken the whole world by its shoulders. In your observations over the past almost two years, what has been the impact of COVID-19 on the food chain and what are some key recommendations in mitigating the food safety challenges?
Food Safety Authority of Ireland (FSAI) is to protect consumer health, we conducted a risk assessment to see if there were likely to be risks to public health from our findings.

At the early stages of the investigation, we did not know the providence of the horsemeat and concluded that veterinary drug residues would constitute the most likely risk to consumer health, if present in the horsemeat. Phenybutazone is a nonsteroidal anti-inflammatory drug used in horses but once used, meat from those horses cannot enter the food chain. We found that this drug was not present in the adulterated beef products we tested. Essentially, there was no risk to public health and Irish consumers were relieved to hear this news but scandalised that they were unwittingly consuming horse meat.

The horsemeat scandal resulted in a loss of confidence in the regulatory control structure in the European Union and many of the shortfalls that existed at the time have been remedied. Initially there were some criticisms of the FSAI but people quickly realised that without the foresight and dedication of the FSAI, this scandal would not have been uncovered and European consumers could still be eating horsemeat masquerading as beef.

Now almost 10 years hence, would you say that it was the catalyst that was needed for the strengthening and revision of food fraud detection policies and frameworks in Ireland and Europe as a whole?

Yes, it was a real wake-up call for the European food sector and demonstrated how vulnerable the food chain was to criminal activity and unscrupulous fraudsters. Since 2013, many initiatives have taken place in the European Union (EU) to protect citizens and ensure that foods are correctly labelled and risks from food fraud are reduced. Many countries have established national systems for improved collaboration between food regulatory agencies and the national police force and customs controls.

The EU Food Fraud Network\(^4\) was established for sharing intelligence between Member States; food controls have been strengthened and regulations now include greater financial penalties for fraudsters; and the Knowledge Centre for Food Fraud and Quality (KC-FFQ)\(^5\) was established to provide and share up-to-date scientific knowledge on food fraud and food quality issues. For instance, EU food control regulations\(^6\) now include a provision for “financial penalties applicable to violations of the rules perpetrated through fraudulent or deceptive practices to be sufficiently deterrent and set at a level which seeks to exceed the undue advantage for the perpetrator resulting from those practices”.

What is alarming is the fact that this adulterated beef incident remains just one of innumerable such food crimes that still occur throughout the world. Apart from species substitution, the other common example of false labelling is where it concerns seafood which may have been illegally harvested. How do we make it difficult for producers and exporters in countries which may not have strict guidelines in place, to ship their products which may be contaminated and/or non-traceable to global markets?

The most effective way to discourage seafood fraud and prevent the marketing of illegally captured (IUU) fish is to strengthen regulations and food control systems, especially monitoring and surveillance activities. The challenge for food regulators is to stay one step ahead of the criminals. There are now DNA-based methods to improve traceability and to authenticate species and the geographic origin of seafoods. International organisations should assist low-income developing countries (LIDCs) to strengthen their regulations and controls to discourage food fraud, IUU fishing activities and promote sustainable fisheries.

And in closing, what are your recommendations for large food retailers who are looking at products to add to their store shelves? Particularly processed products (breaded, minced, etc) containing additives and other enhancement ingredients, where it is difficult to know what went into them?

The prevention of food fraud is essential for all large food retailers to protect the health and interests of their consumers, to maintain the trust of customers and to maintain ethical and sustainable business practices. Food retailers need to develop mitigation measures against food fraud threats specific to their businesses and to minimise the risk of purchasing fraudulent or adulterated food products. Specifically, they need to establish evidence-based mitigation measures based on risk assessment and vulnerability analysis. This will involve firstly undertaking vulnerability assessments to identify potential sources of food fraud within their supply chains; and secondly, to prioritise control measures to minimise the chances of receiving fraudulent or adulterated ingredients, raw materials or products. A key aspect of such initiatives is to undertake product and supplier vulnerability assessments on all raw materials, ingredients, packaging, and food products.

\(^1\) https://ec.europa.eu/food/safety/agri-food-fraud/eu-food-fraud-network_en
\(^2\) https://knowledge4policy.ec.europa.eu/food-fraud-quality_en
\(^3\) https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32017R0625&from=EN
A MOMENT FOR INDONESIAN AQUACULTURE TO ACCELERATE COMPETITIVENESS THROUGH THE PRESENCE OF STARTUPS

By Asep Bulkini

The digital revolution that is currently happening around the world is also impacting upon Indonesian fisheries, especially in the aquaculture sector. Various digital and technology-based startups have sprung up in the last five years providing digital, AI and IoT-based water quality tools and automatic feeders; financial technology and management investment; and online-based marketplaces for inputs and harvested products. In doing so, they are instrumental in providing solutions to some long-standing problems which make national production less efficient and less competitive. Their presence makes uncertain and high-risk aquaculture more predictable and promising.

Digitisation brings new hope

These problems have persisted for a long time and kept productivity at an inefficient level, especially for freshwater commodities such as pangasius and catfish which typically fetch low prices.

Meanwhile, to gain a competitive advantage over other countries, Indonesia still faces many technical and non-technical challenges. This weakness can easily be seen in the fact that the value of its fishery production is currently lower than another ASEAN country, Vietnam. Although Indonesia’s production reached 5.4 million tonnes in 2018, it was worth only US$12 million while Vietnam’s output was lower (4.1 million tonnes) but it was valued at US$14.5 million. For example in the case of *vannamei*, the average farm gate price is higher by around US$0.5-1 per kg than the level in Vietnam.

This lack of competitiveness of Indonesian aquaculture products at the global level is caused by many factors throughout the value chain. These include inefficient economies of scale for small farmers, inadequate seeds in terms of quality and quantity for some commodities, low application of the latest technologies, diseases and non-optimal environmental quality, low prices for some species, and limited access to markets and finances. Some government regulations are also counter-productive, representing another challenge.

Digitisation brings new hope

These problems have persisted for a long time and kept productivity at an inefficient level, especially for freshwater commodities such as pangasius and catfish which typically fetch low prices.
However, in the past few years such problems are being tackled by young fishery entrepreneurs as well as millennials who are technologically literate and interested in trying out their ideas in aquaculture. One of them is a recent graduate from The Bandung Institute of Technology (Institut Teknologi Bandung/ITB) Gibran Huzaifah who went into culturing catfish. He found that the system carried out by most of the farmers surrounding him was inefficient and he attributed this to deficiencies in their feeding management approach. Feed is the biggest cost in cultivation, constituting 60-80%.

Because of that, he then founded a startup called eFishery in 2013 which initially focused on making automatic feeders (autofeeders) to overcome the inefficiency issue in manual feeding. This tool can optimise feeding management so that it is not governed by the working hours of the workers but rather, the natural behaviour and needs of the fish. In other words, it allows feeding to be carried out at the times that suit the fish’s need to eat, instead of during human working hours so that the process of metabolism and fish growth can be more efficient.

After eFishery was established, other startups emerged in the aquaculture industry several years later. The presence of these tech-based companies make aquaculture more attractive and demonstrate higher potential. These startups then joined the Digifish Network, a fisheries startup community which was initiated in 2018 by Rully Setya Purnama, CEO of aquaculture marketplace Minapoli, along with eFishery (autofeeder) and other startups including Jala and Venambak (water management); Iwake (market and system production); and Growpal and Infishta (financial technology). To date, there are more than 30 startups in the aquaculture and fishery sectors who are members of this network, ranging from pre- and post-production and supporting industries.

They entered the aquaculture industry in a good way, in terms of not disrupting the existing players. Because there were many problems in aquaculture, they could enter niche segments that had not been worked on by previous players. For example, eFishery offers an automatic feeder solution for inefficient feeding problems; Minapoli has created a new way of seeing to farmers’ trade needs through online and one-stop shopping; while the financial technology (fintech) companies offer support for farmers who have had difficulty accessing financial institutions due to the high risk nature of aquaculture. Water quality management web-based tools are also now in the market which not only check the water, but also provide analysis and treatment recommendation through apps. These all make it easier for startups to collaborate with integrated fisheries companies that already exist and which usually focus on hatchery, feed and nutrition, and health products.

One of the actors in the aquaculture value chain that might face disruptions is the middleman who, in normal circumstances, makes the value chain longer. As a result of this long value chain, for freshwater commodities such as tilapia, catfish, gourami, and carp, the difference between farm gate and end-consumer prices can reach IDR 10 000 - 15 000/kg (USD 0.7-1/kg), which is about 50-75 percent higher than farm gate price. This is usually not good for farmers who do not get fair prices and also not good for consumers who need fish at an affordable price.

More precise, more predictable

Specific to the production process, the showing up of these new technologies make the farming process which has so many parameters, become more predictable. So far, on-farm aquaculture has often been considered a high-risk economy due to the uncertainty of its results, which discourages financial institutions from entering and funding this potential business sector. It becomes a vicious circle that hinders the productivity and competitiveness of aquaculture.

However, the technologies brought by startups help to minimise these production risks. In water quality management, the segment that most startups enter, water quality measurement tools are available that can generate data more quickly and precisely. JALA, AquaEasy, or FisTx are examples of such startups. Moreover, these measurement tools can even provide predictions of what will happen or what farmers will need to do in the coming days. This is possible thanks to at least three important things: (i) better sensors that can retrieve data more precisely; (ii) Internet of Things (IoT) which allows the measurement data to be transferred more quickly to other devices or servers;
and (iii) Artificial Intelligence (AI) providing precise, fast, and so much data which make predictions about what will happen and can recommend what steps need to be taken by farmers. This allows farmers to make decisions based on data, instead of ‘feeling’ as was commonly done before.

Better sensors, IoT, and AI are also the main features in autofeeders which make feed management more effective based on the cultured species and its behaviour. IoT allows production activities data to be displayed on apps or websites on smartphones or computers. Farmers can monitor or even operate feeding activity anytime and anywhere by tapping the features in the app.

Meanwhile, in the supporting segment, most startups offer financial technology. Their proactive approach helps small-scale farmers who have limited cash flow and access to financial institutions at the same time. The most common features are peer-to-peer lending and investment management. Although this business model looks simple, the challenges are quite large, especially in managing huge funds and assisting small-scale farmers with low technology applications. Perhaps it would be perfect if they could collaborate with other startups that play a role in production technology.

**Time to collaborate**

Digitisation creates more exposure for the aquaculture industry and attracts the attention of many new players who were not in the industry before, especially the millennial generation who may become aquaculture game-changers in the future. Instead of exhibiting shrinking growth due to the COVID-19 pandemic in the last two years, investment in aquaculture and agri-tech in general has shown a convincing increase. This is because of the nature of the industry which provides a protein source meeting the food security needs of humans. The increased investment trend is reflected in the latest funding received by two startups JALA and eFishery, amounting to US$60 million and US$90 million, respectively.

The government has been piloting shrimp ponds for millennials by using digitisation

The interest of investors and millennials who did not have a previous background in aquaculture has brought a new perspective to the industry. For example the engineering aspect, although an important one in aquaculture, has not attracted the attention of many stakeholders with an aquaculture background who could contribute to its development. The main issues of concern in this area are usually related to broodstock and genetics, nutrition and raw materials, and health and water quality management.

With the advent of startups however, engineering has become a new focus. Many startups have succeeded in accelerating its development through the application of engineering-based innovation. For example, autofeeder machines with more precise sensors that, combined with IoT, are able to automatically feed the fish and shrimp at the right time and amount according to their needs. This has given rise to feed efficiency solutions seen from a new perspective, beyond the tinkering with nutrients and raw materials which was a feature of aquaculture in past years.

Digitisation and engineering also contribute to feed efficiency

Likewise with regard to water quality, the engineering approach combined with IoT and Artificial Intelligence allows farmers to not only measure water quality quickly and precisely, but it also can make predictions and treatment recommendations based on the results of the latest analysis.

The coming of new players with broader backgrounds is generating good momentum for aquaculture acceleration in Indonesia because aquaculture basically is a combination of various disciplines. The various problems faced, of course, require many approaches from all perspectives. This development has been changing the nature of aquaculture in Indonesia from a high-risk uncertain business to a more predictable one so that it is more open and easier for new people with wider backgrounds to enter, and not exclusively the old players.

**The opportunities and challenges**

Besides being able to increase productivity of the farm directly, IoT and digitisation can also raise the productivity of the owner personally. In Indonesia, many farms (especially shrimp) are owned by entrepreneurs who have other businesses to attend to. They hire experienced technicians to
be in charge of production and may not always be at the pond site. With the new developments, it is possible for owners to monitor their farms in real time from anywhere so that they can streamline their visiting schedule with other jobs.

The presence of tech-based startups needs to be seen as a new impetus in treading the long road of competitive aquaculture. However, the new tools do not automatically make Indonesian aquaculture directly competitive. This can be seen from the increase in productivity which has nevertheless, not been as significant as the growth of the startups themselves. Although they bring a breath of fresh air into the sector, their presence also bring their own challenges that need to be resolved in order to accelerate development.

Infrastructure is one of the challenges, with the existence of production centres generally being in rural areas that are far from the cities and settlements. There, telecommunication infrastructure is still not evenly developed whereas the foundation of digitisation is a capable internet network made available through proper infrastructure. Let alone the telecommunication infrastructure, in some locations even the electricity infrastructure does not reach the pond areas, so the farmers at those locations can only rely on diesel-fueled generators. The government needs to intervene in building this infrastructure so that the ecosystem for the growth of digitisation runs smoothly.

Another challenge is the application of products or services efficiently in the field, especially for freshwater commodities which typically have low adoption. There are at least three things that hinder the application of new technology in the freshwater aquaculture segment.

First, most of the freshwater fish farms are small-scale both in terms of land area and financial capacity. Whether the application of the new technology is quite efficient on a small-scale farm or not is a dilemma. Innovators need to make each product or service applicable at the smallest scale of cultivation.

Second, the prices of freshwater fish are generally much lower than shrimp and other mariculture species. This makes profit margins very thin and farmers are less free to add additional costs in adopting new technologies.

And the third challenge of implementing the new technology is the level of acceptance by farmers. Many fish farmers have basic education, usually relying on knowledge of fish cultivation obtained from field experience and from generation to generation. Their literacy rate and understanding of new technology is not as high as shrimp owners, who are usually more well educated. This low level of technology use can be a barrier to exponential growth for the startups themselves and aquaculture productivity in general.

Therefore, farmers should remain at the centre of the development initiatives carried out by startups. A startup entity today can increase its value through organic business growth with the sale of products and services and venture capital from investors with an exponential growth potential. While organic growth reflects the fact that the products or services created by startups are applicable in the field, lucrative multiplication of funding from investors should not reduce the focus of the startup’s main mission, which is to help farmers level up.

By placing farmers at the centre of development, the startup ecosystem will be sustainable because it provides benefits for farmers as users and also for companies as technology providers.

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HOW MANDATORY TESTING OF BALLAST WATER MANAGEMENT SYSTEMS PROTECTS FISHERIES AND AQUACULTURE

By Ersi Zacharopoulou, Lisa Drake, and Guillaume Drillet

Invasive species can cause irreversible damage to both marine biodiversity and industries such as fisheries and aquaculture, which depend on a clean environment. As one source of pathogens is the ballast water that is discharged from ships, it is crucial for regulatory authorities and industry stakeholders to ensure that vessels are in compliance with the International Convention for the Control and Management of Ships’ Ballast Water and Sediments, 2004 (BWM Convention), which entered into force globally on 8 September 2017. This article calls for mandatory testing of the ballast treatment management systems (BWMS) installed in ships to verify their efficacy in preventing harmful species from being introduced.

Greater than 50μm viable organisms (typically zooplankton)

In all areas of the world, the fisheries and aquaculture sector contributes significantly to food security, supporting the wellbeing of billions of people, from food-abundant regions to the most food-limited regions. Aquaculture is expected to be the main driver for the increase of fish production globally. By 2030, global aquaculture production is projected to reach 103 million tonnes, six tonnes more than the capture sector, as mentioned in the OECD-FAO Agricultural Outlook 2021-2030 report.

One way to secure and optimise food security is for countries to prevent invasive, harmful aquatic organisms from entering coastal aquatic ecosystems and causing irreversible damage to marine biodiversity. Further, industries dependent on the marine environment, like fisheries and aquaculture, can be potentially negatively affected. These introductions may occur through many sources. One notable vector is shipping activity, and aquaculture activities are particularly vulnerable as they are typically located in the vicinity of ports. As ships discharge ballast water, they could introduce pathogens to aquaculture facilities. Indeed, there is clear evidence of the role of ships in the global distribution of protozoans, bacteria, and viruses via ballast water and sediments, as well as in biofilms on the ballast tank surface.

International response: the BWM Convention

The International Maritime Organization (IMO) addressed this broad concern of ballast water transferring “harmful aquatic organisms and pathogens” by adopting the International Convention for the Control and Management of Ships’ Ballast Water and Sediments, 2004 (BWM Convention), which entered into force globally on 8 September 2017. Its aim is to reduce and prevent the spread of potentially invasive species in ships’ ballast water. Most ships are transitioning to use onboard, specialised, approved equipment — called ballast treatment management systems (BWMS) — to reduce the risks from vessels’ discharges in aquatic environments. This article examines the necessity of mandatory testing when new BWMS are installed and undergo “commissioning testing” to verify their efficacy as a preventive measure against the introduction of harmful species, which may enter coastal waters and affect the sustainability of fisheries and aquaculture.

The BWM Convention dictates that ships trading internationally shall carry a ballast management plan, a ballast water record book, and an International Ballast Water Management (IBWM) certificate. This certificate, which is issued by, or on behalf of, the Administration (i.e. the ship’s flag State), certifies that the ship carries out ballast water management in accordance with the BWM Convention. For nearly all ships, this involves installing BWMS designed to treat the ballast water to meet the BWM Convention’s
discharge criteria (outlined in regulation D-2, also known as the D-2 standard). The D-2 standard specifies that ships must discharge ballast water with a very low concentration of living organisms, thereby reducing the transfer of potentially invasive species. The criteria in the D-2 standard are:

- Less than 1 colony-forming unit (cfu) per 100 millilitres of toxicogenic *Vibrio cholerae*;
- Less than 250 cfu per 100 millilitres of *Escherichia coli*;
- Less than 100 cfu per 100 millilitres of Intestinal *Enterococci*.

Commissioning testing is the process to verify that a BMWS’ installation is correct. It is logical that after a BWMS is installed at a shipyard, it should be tested as a whole to validate that the system is operating as intended and according to its type approval requirements. By also conducting biological efficacy testing, the D-2 standard of the BWM Convention can be verified as having been met at that time. Thus, effective management of the discharge is confirmed, and a level of protection is provided to marine biodiversity and marine economies.

As more BWMS are installed and commissioning testing proceeds worldwide, the observations and results from commissioning and compliance testing events conducted by approved service providers will be studied thoroughly by the IMO during the “Experience Building Phase” of the BWM Convention. These results will be used to inform rules for future mandatory testing. This will reduce the risk of unmanaged ballast water having economic impacts (e.g., reduced food safety, unemployment).

**BWMS commissioning testing becomes mandatory this June**

During the recent virtual 77th Meeting of the IMO’s Marine Environment Protection Committee (MEPC) held from 22-26 November 2021, matters related to the BWM Convention were considered. The MEPC approved a “unified interpretation” of the date to implement mandatory commissioning testing of BWMS in accordance with resolution MEPC.325(75); in other words, BWMS commissioning testing will be mandatory after 1 June 2022. Currently, some flag States (e.g., Australia, Canada, Croatia, Cyprus, France, Greece, India, Singapore, and Tuvalu) are already requiring mandatory testing. Other flag States have declared that commissioning testing is strongly recommended until 1 June 2022.

For the flag States that have not yet implemented mandatory commissioning testing—in advance of it being required by the BWM Convention—doing so would be an important decision, as it would reduce risks to marine environments as well as blue economies, including fisheries and aquaculture. Note that some clarifications by the IMO are expected in the future concerning the commissioning testing of BWMS that were installed before 1 June 2022; a good approach would allow testing to remain optional or at the discretion of the Administration. In this way, older BWMS installations, when there was limited or lack of experience at shipyards, could be tested and corrected as appropriate.

MEPC 77 also commented on developments regarding the BWM Convention’s Experience Building Phase. The IMO urges port States, flag States and other stakeholders to collect and submit data to the ballast water experience-building phase. In November 2021, it was noted that data are now available from 35 Member States and seven other stakeholders, corresponding to approximately 15 000 ships (approximately 60 000 ships in the global fleet are expected to install BWMS). This data are being analysed by the World Maritime University, and a full report will be submitted to MEPC 78, which will be held on 6-10 June 2022. All of these events are strong drivers in the protection of the marine environment, including fisheries and aquaculture development.

**Experience gained from commissioning testing data**

SGS Marine Field Services & Monitoring, as an approved service provider by most Classification Societies, has conducted 660 BWMS commissioning tests as of January 2022. Of these BWMS, some were tested on a single ship (multiple BWMS installed), and some were tested multiple times (e.g. re-tested after a failure).

SGS marine teams have carried out commissioning testing on BWMS from 29 manufacturers in 26 countries worldwide, representing in-line and in-tank treatment. As is reflective of the industry, the BWMS tested typically consisted of a filtration step followed by physical (e.g. ultraviolet) or chemical (e.g. chlorination and ozonation) disinfection. Given the location of the bulk of the world’s shipyards, it is not surprising that
most of the commissioning testing so far has occurred in Asia: China (48%), Singapore (19%), and S. Korea (18%) (Figure 1).

**Figure 1: Locations of commissioning tests**

Accordingly, the ships on which the commissioning tests occurred were mainly flagged under Singapore (48%), Panama (14%), Cyprus (10%), Bahamas (7%), Liberia (5%), and Greece (4%) (Figure 2). It is expected that more flag States will make the commissioning test mandatory before 1 June 2022, when it will be required according to the BWM Convention, as mentioned previously.

**Figure 2: Flag States of the ships tested**

### Sampling and analysis

For the purpose of commissioning testing, a volume of 3 m³ is filtered to determine the concentration of organisms in the ≥50 µm size class, and a sample volume of 10 L (sampled continuously) is collected for organisms in the ≥10 µm and <50 µm size class and the group of indicator microbes. Sampling is implemented through a validated portable Ballast Water Sampler following the IMO G2 Guidelines. In some cases, because the sampling probe installed onboard may be small and/or because operational situations limit the volume of treated water that may be discharged, the volume of the sample for the ≥50 µm size class may sometimes be lower than 3 m³. Regardless, it is always at least 1 m³.

Two types of analysis may be conducted: “indicative” analysis (a rapid assessment, typically done onboard the ship) and “detailed” analysis (more in-depth, typically completed in a laboratory). To determine the concentration of organisms in all three size classes using indicative analysis, the concentration of adenosine triphosphate (ATP) is measured in the samples. Next, the concentration of ATP is correlated to the concentration of viable organisms. For detailed analysis of organisms in the ≥50 µm size class, the collected organisms are counted using a stereomicroscope in a Bogorov counting chamber.

Notably, because the results of detailed analyses prevail over those of indicative analyses, most clients would agree that detailed analyses should be carried out in cases where indicative analyses show a likelihood of non-compliance. In 81% of the tests, the analyses were stopped after the indicative analyses, and in 16% of the tests, additional detailed analyses were carried out after the indicative tests showed likely non-compliance, and 3% of tests were conducted only using detailed analysis (Figure 3).

**Figure 3: Analysis approaches**

When both indicative and detailed analyses were completed, in 76% of the cases, the detailed analyses provided data to refute the results from indicative testing, therefore demonstrating the ship’s compliance with the discharge standard. This result clearly indicates the great value in considering detailed analyses in commissioning testing—even if it is used as a secondary testing approach—to ensure that the owner does not have to carry out a second, separate sampling event.

Overall, combining all testing approaches, 13% of the installations did not meet the D-2 performance standard of the BWM Convention. Failures were overwhelmingly found in the largest size class of organisms (≥50 µm). In many respects, the resistance of the larger organisms to treatment is not
surprising, and it illustrates need to ensure that the filtration step (which is present in nearly all BWMS) is well-functioning (e.g. the integrity of the filter must be assured). In the future, it will be important to ensure that the BWMS continue to function as intended; i.e. port State control measures will be needed to maintain environmental protection.

In 10% of the tests, the total residual oxidant (TRO) level in treated, discharged water from BWMS using active substances was higher than the limit of 0.1 mg/L used by the Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection (GESAMP) to evaluate BWMS. High TRO values in treated, discharged ballast water are an emerging issue for ballast water management, because while high TRO concentrations likely ensure that the D-2 standard is met, the concentrations may be in violation of local, state, or federal requirements and may negatively affect the marine environment where the treated water is discharged.

**Observations**

At this stage, not all the causes for the failures observed are evident. The failures noted—while not providing a clear picture of the source of failure—indicate that installation can affect the performance of BWMS shown to be effective during type approval testing. If not corrected, this pattern of failures will continue to be seen during compliance assessments by port State control authorities during the life of the ship, resulting in an ongoing compliance risk to the vessel as well as risk to the marine environment and blue economies in the locations where ballast water is discharged.

**Conclusions and call for action**

Overall, combining all commissioning testing approaches, 13% of the installations did not meet the D-2 performance standard of the Convention, and failures were mainly found in the largest size class of organisms (≥50 μm). This percentage is high relative to the number of vessels in the global fleet that have not yet installed and commissioned BWMS. To avoid adverse economic and ecological impacts from discharges of unmanaged ballast water, a main objective of members of fisheries and aquaculture communities should be to interact with Administrations to ensure that the BWM Convention is appropriately implemented in their area.

It is recommended that stakeholders (authorities, fisheries and aquaculture companies, etc.) should develop (or refine) specific action plans for preventing and managing invasions. This includes monitoring, mitigating, and restoring affected areas to ameliorate the effects of marine biological invasions on local biodiversity, human health, and ecosystem health. Monitoring would include, for example, water quality parameters, continuous monitoring of physicochemical parameters, ecotoxicological testing, and molecular approaches (e.g. environmental DNA testing). Part of this plan should be proposals for the management of coastal and marine protected areas and the development of campaigns to engage citizens. In sum, at the moment, international organisations and stakeholders are committed to using the BWM Convention to protect marine ecosystems and economies. It will be important to ensure this protection continues.

**Disclaimer:** The views and opinions expressed in this article are those of the authors and do not necessarily reflect the official policy or position of SGS. Assumptions made within the analysis are not reflective of the position of SGS.

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THE CONFERENCE

TUNA 2022, the premier convention of the world tuna industry is back this year and will be held from 11 – 13 October 2022 in Bangkok, Thailand, the “global tuna capital”. The 17th INFOFISH World Tuna Trade Conference and Exhibition is set to take shape as a first ever hybrid event with options for attendees to either join virtually or to be in-person at the prestigious Shangri-La Hotel, Bangkok. The theme of this year’s conference is ‘Strengthening Resilience, Adaptability and Sustainable Growth in the Global Tuna Industry’.

The biennial INFOFISH World Tuna Trade Conference and Exhibition has over the years been an event looked forward to by the global tuna industry, serving as a platform to discuss present and unfolding challenges and opportunities in maintaining and further encouraging a socially, economically and environmentally sustainable global tuna market, as well as to connect and network with all segments of the sector. This year’s event, aside from its unique setting/configuration offers a two and a half days interactive and insightful programme that is very relevant to our current disruptive and ever-changing global market dynamics.

Over the years, this event has been able to attract a global audience of almost 600 delegates from nearly 70 countries comprising distinguished representatives from prominent fishing companies, exporters, importers, canned tuna packers, agents, brokers, retailers, equipment suppliers, researchers and analysts, consultants, financiers, international spokespersons, and governmental as well as non-governmental organizations. The TUNA 2022 hybrid event offers an even greater opportunity that serves a unique purpose in expanding audience connectivity and its networking scope with the major tuna industry players and stakeholders as well as building a dynamic experience for our attendees both online and in-person. It also creates differentiated sponsorship opportunities for all.

With travel restrictions eased throughout Thailand beginning of February 2022, and with the return of Test & Go for fully vaccinated travellers, Bangkok remains the most suitable of venues to accommodate this large tuna industry event, being home to many major global tuna industry players in addition to its excellent meeting facilities and good services.

THE INDUSTRY

According to FAO Globefish, the global tuna trade in 2021 has been characterized by improved demand for non-canned tuna, falling retail demand for canned tuna and improved sales opportunities in the hotel, restaurant and catering (HORECA) sector, particularly in the Western markets. On the supply side, tuna catches were low worldwide during the third quarter of 2021, balancing slow demand for frozen raw material from tuna canners; however, prices continue to be under pressure due to lack of demand for end products.

As the premier event in the industry’s calendar year, TUNA 2022 is anticipated to bring together a large number of key stakeholders and broad representation globally to discuss a wide range of issues, challenges and opportunities in support of the sector’s continuing vitality, viability and sustainable growth in what has been and continues to be a disruptive operating environment for all industry players. Following on from TUNA 2021 (The Global Tuna Industry: Trailblazing through tough times), this meeting of the industry will continue to provide a very opportune moment for further reflections and conversations on high level developments and practical approaches to ‘Strengthening Resilience, Adaptability and Sustainable Growth in the Global Tuna Industry’.

As an industry, tuna producers and suppliers have had to, and continue to be resilient actors and players in the supply chain and market in responding to industry risks and sustainability issues. This is resilience and adaptation through innovation, science and technology, greater efficiency in production and product diversification, value adding, creative marketing strategies and leveraging e-markets to maintain and grow new markets.

TUNA 2022 is also an opportunity to raise further industry-wide issues and initiatives to the fore, such as Illegal, Unreported and Unregulated Fishing (IUU), trade and market access issues, social accountability, eco-labeling and certification, Fishery Improvement Projects and sustainability efforts,
the implications of COP22 and a future with tuna farming, amongst a range of other industry matters.

While the industry has been greatly challenged, it has also been a great example of resilience, adaptation and endeavour in a constantly changing business environment. The emergence of rapidly changing technologies has also provided alternatives in terms of business approaches, market behaviour, health, safety and sustainability, and there are many lessons and reflections to be shared that will provide very stimulating and exciting exchanges for all participants over the course of TUNA 2022.

THE VENUE & ACCOMMODATION

The 5-star luxury Shangri-La Hotel will again be the venue of TUNA 2022. Ideally located on the bank of the Chao Phraya River and adjacent to the sky train, it takes about 30 minutes to arrive at the hotel from the Suvarnabhumi International Airport. Rooms at reduced rates have been blocked at the Shangri-La and at several other satellite hotels nearby.

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E-mail: reservations.slbk@shangri-la.com, Web: www.shangri-la.com
For hotel reservations, delegates are requested to submit the hotel registration form provided, directly to Shangri-La Hotel or to the satellite hotels. Hotel registration forms are available from our website: http://tuna.infofish.org/

SAFETY MEASURES

Shangri-La Bangkok, is a Thailand Safety and Health Administration (SHA) Plus+ certified hotel and has been awarded the SafeGuard Hygiene Excellence and Safety Label by Bureau Veritas. Shangri-La has embraced a series of enhanced safety standards and has a highly vaccinated workforce.

TRAVEL ADVISORY

Delegates who are attending the physical conference are advised to refer to the Thailand Pass website (https://tp.consular.go.th/) for registration to enter Thailand.

THE EXHIBITION

An exhibition will also be held concurrently at the same venue. A total of 40 booths are available for companies and organisations to display and promote their products, equipment, machineries and services related to the industry. Reservation of booths is on a first-come, first-served basis.

SPONSORSHIP & PROMOTIONAL PACKAGES

INFOFISH is inviting companies and organisations to be a partner of this prestigious event by signing up for the sponsorship packages - Platinum, Gold, Silver or Bronze - which offer attractive and real benefits to sponsors. Promotional packages are available for companies who are interested to effectively advertise and promote their products or services for better impact and greater visibility during TUNA 2022, all at reasonable charges.

SIMULTANEOUS INTERPRETATION

Simultaneous interpretation of presentations from English to Spanish will be provided throughout the two and a half days event for the benefit of Spanish speaking delegates.

PROGRAMME HIGHLIGHTS

- Global trends and sustainability initiatives
- Overview of global tuna resources and supply
- Global tuna markets, trade and marketing: Embracing changes
- Impact of raw material prices on global tuna trade
- Market adaptability and technological innovations
- Adapting to the new global trade reality
- Revisiting sustainability through the pandemic
- Supply chain/logistics challenges
- Technology and innovations for a safer, secure and sustainable tuna industry
- Blue Food revolution: Balancing demand, supply and sustainable tuna stocks
RESERVATION INFORMATION:
A total of 40 booths are available and allotted on a first come - first served basis. Make your booking by 22 AUGUST 2022 and enjoy an early booking rate of US$ 3,500 under PLAN A or US$ 2,900 under PLAN B.

Once booking is made, an application form will be forwarded with the general information to be endorsed and signed for booking confirmation.

INFOFISH as the organiser, reserves the right to make amends and changes as it considers fit in the overall interest of the TUNA 2022 exhibition. Terms and conditions apply within.

For enquiries, please contact: Mr Mohd Syahir, Tel: (603)80668112, E-mail: syahir@infofish.org / info@infofish.org
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PROMOTIONAL PACKAGES

PRO 1
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Deadline for receipt of material ................................. 5 September 2022
(Materials to be sent directly to conference site)

PRO 2
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As the sponsoring magazine, INFOFISH International will be distributed to all conference delegates, exhibitors and visitors. This is in addition to the normal worldwide distribution.

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Please type or print as required to appear on name badge and participants list. Form may be photocopied if needed. Please return this form to INFOFISH duly filled.

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The registration fee will be refunded, less 25% for cancellations received before 20 July, 2022. No refund can be made for cancellation after 20 July 2022. However, a substitute delegate may attend in place. Refunds will be issued only after the conference.

* Bangladesh, Cambodia, Fiji, Iran, Malaysia, Maldives, Pakistan, Papua New Guinea, Philippines, Solomon Islands, Sri Lanka and Thailand.

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Tel: (603)80668112 | Fax: (603)80603697 | E-mail: info@infofish.org
New multi-species broodstock facility

The Philippines - A new multi-species hatchery and broodstock facility located at the Tigbauan Main Station of the Southeast Asian Fisheries Development Center (SEAFDEC), was inaugurated in December 2021. The facility was set up between 2019 and 2021 in support of the DA-Bureau of Fisheries and Aquatic Resources (BFAR)’s Bangus Fry Sufficiency Programme. It will produce and distribute good quality seeds, and serve as a prototype for other hatchery business ventures in the country.

The four broodstock tanks have a holding capacity of 2,000 tonnes or about 400 milkfish breeders, and are projected to produce 320 million eggs annually. In the marine hatchery section, about 20 million milkfish fry, 5.4 million pompano fry, 14.4 million shrimp postlarvae, and 2.5 million crab instars are expected to be produced in these facilities every year. Meanwhile, the freshwater hatchery is projected to produce 16 million catfish fry, 4.5 million freshwater prawn postlarvae, and/or 910,000 tilapia fry per year.

Making seaweed work for everyone

Singapore - A start-up called Sea Green says that it “offers a fully integrated solution for seaweed farming based on a technology platform that facilitates a

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more democratic value chain for coastal communities around the world”. Based in Singapore, the company is already working alongside coastal communities in Indonesia to promote inclusive growth, strengthen coastal resilience, and tackle climate and ecological issues.

According to Sea Green, the digital platform connects seaweed value chain actors together through data. Offering value add front-end services through web and mobile apps, the platform creates collection channels for a wide range of value chain information. This is collected and stored for analysis and connectivity to other services, driving research, iterative improvement and provision of new services back into the value chain. It also allows for blockchain inter-operability and real-time collection of environmental data.

**Urchinomics formally endorsed by the UN**

Norway - The United Nations (UN) Decade of Ocean Science for Sustainable Development (2021-2030) (Ocean Decade) has announced that Urchinomics is at this time one of only three commercial ventures in the world to be formally endorsed as an Ocean Decade action. The UN Ocean Decade sets out a framework to catalyse transformative ocean science solutions for sustainable development, connecting people and the ocean.

Mr Julian Barbière, Coordinator of the Ocean Decade from the Intergovernmental Oceanographic Commission of UNESCO stated that, “We’re always seeking to identify partners, initiatives and commercial ventures that aim to secure the future of the oceans, and indeed the welfare of our planet. Urchinomics’ solution for innovation in the production and processing of seafood that also supports restoration of kelp forests is very much part of the multifaced solution we seek to identify and promote in the framework of the Ocean Decade.”

Norway-based Urchinomics is operating commercially in Japan, and actively setting up operations in California, Canada and Norway to help combat the destruction of kelp forests. *(Editor’s note: An interesting interview with Brian Tsuyoshi Takeda, Founder and CEO of Urchinomics, was published in the November/December 2021 issue of the INFOFISH International).*

**Launch of EU4Algae**

Europe - The European Commission, the European Climate, Infrastructure and Environment Executive Agency (CINEA) and a consortium of sustainability consultants and algae organisations are launching EU4Algae, a European algae stakeholder platform. This 3-year project will accelerate the scale-up of a regenerative, resilient, fair and climate friendly algae industry in Europe, and bring more novel algae species to the EU market.

The platform will be a unique space for collaboration among European algae stakeholders including algae farmers, producers, sellers, consumers, technology developers as well as business organisations, investors, public authorities, academia, researchers and NGOs. It will also act as a single information hub on algae funding calls, projects, business-related information, intelligence and best practices.

**Region’s first RAS facility for shrimp**

UAE - The establishment of a shrimp RAS farm in early 2023, the first in the region, was announced recently. The farm will have a production capacity of over 1,000 tonnes of shrimp annually, which would quadruple the UAE’s current shrimp production. The UAE currently imports 51,000 tonnes of shrimp per year.

The farm will be built and operated by Prime Aquaculture, a subsidiary of Emirates National Aquaculture, which signed a memorandum of understanding with Jebel Ali Free Zone (Jafza). Imtiyaz Abdul Razak Kalsekar, MD of Prime Aquaculture, said, “The UAE consumes about 220,000 tonnes of seafood annually, with imports covering 70 percent of this figure. One of the key pillars for the UAE’s National Food Security Strategy is to achieve self-sufficiency.

**Focus on blue economy during G20 presidency**

Indonesia – In taking over the presidency of the G20, a grouping comprising 19 countries and the EU, Indonesia is focusing on three main pillars: Global Health Architecture, Sustainable Energy Transition, and Digital Transformation. One area that will be given emphasis is the importance of the blue economy, blue carbon, and also marine debris handling. Indonesia is ready to partner with all parties to create a sustainable marine ecosystem, said President Joko Widodo.

“At the global level, Indonesia continues to support the mainstreaming of marine issues. Indonesia’s Presidency of the G20 will highlight the importance of a
blue economy, blue carbon, and marine debris handling,” he remarked at the One Ocean Summit last October.

At the domestic level, Indonesia has made several breakthroughs for managing the marine environment in a sustainable manner. These include policies for fish handling in a measured and quota-based manner, supported by a technology-based monitoring system; as well as the development of an aquaculture village based on local wisdom for poverty alleviation and preservation of high economic value commodities, he added.

Three-month fishing ban in effect

Thailand - The Fisheries Department has announced a three-month closure (until 15 May 2022) of the southwestern part of the Gulf of Thailand to large fishing operations to allow time for fish to breed and nurture their young. The ban affects large-scale commercial fishing in the sea off Prachuap Khiri Khan, Chumphon and Surat Thani.

Chalermchai Suwanrak, deputy chief of the Department, said the seasonal closure is part of its policy to rehabilitate and restore marine stocks and ensure sustainable fishery practices. Previous bans have been successful in boosting the populations of mackerel and other small commercial fish in the Gulf of Thailand.

There will be two more fishing bans in Thailand this year. The first period from June 15 to Aug 15 will be effective in the northwestern part of the Gulf from Prachuap Khiri Khan’s Hua Hin district to Samut Sakhon’s Muang. The second period from Aug 1 to Sept 30 affects the northeastern part of the Gulf from Muang to Si Racha district in Chon Buri.

Nationwide tuna harvest strategy

Indonesia – A nationwide harvest strategy for Indonesian tuna will be implemented in an effort to protect the country’s wild stocks, and also help the government’s ongoing push to achieve sustainability certification for its fisheries. Furthermore, having such a nationwide harvest strategy is in line with the country’s focus on the blue economy (see previous note) which emphasises a balance between economy and ecology.

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The 7th Pre-Technical Harvest Strategy Workshop for Tuna Fisheries in Indonesian Archipelagic Waters, October 2021
Particularly noteworthy is the fact that South Korea has overtaken China’s long-held position as the main Asian market. In 2020, Russia sold more than one million metric tonnes of seafood (mostly pollock) to China, representing 61% of its total seafood exports by volume. However, in late 2020, China said that traces of COVID-19 had been found on the packing of seafood products imported from Russia. Consequently in the first half of 2021, Russian seafood shipments to China fell 83% by volume compared to 2020, and nearly half in value. Although there was some progress in January 2022 with the opening of the Dalian and Qingdao ports for Russian shipments, Russian officials continue to encourage exporters to look towards other markets.

In this regard, it has been reported that the non-profit organisation “Russian Fish”, which was set up in 2018 by the Russian Federal Agency for Fisheries, will have a big role to play in diversifying the markets for Russian seafood.

Expected rise in investment in 2022

Indonesia – Antara News has reported that the Ministry of Marine Affairs and Fisheries forecasts investments in the fisheries sector to rise by 4-5% this year, boosted by several new policies, said the Ministry’s Director of Business and Investment, Catur Sarwanto. Furthermore, the new policies are expected to diversify investments from Java to other regions in the country, and also from fishing to aquaculture and processing.

According to Sarwanto, in 2021, the largest investment in the fisheries sector was seen in aquaculture, reaching about 30 percent of the total investment, followed by the fisheries processing industry (27 percent), and the fish capture and trade sub-sectors absorbing the rest. Overseas investors include China and Singapore.

Direct sales of oysters through vending machines

Japan – To boost sales affected by COVID-19, a Hiroshima-based company called Farm Suzuki is selling its products through vending machines in addition to making them available at its shop
in Hiroshima and online for direct-to-consumer deliveries. There are two machines so far, one located in the Toranomon Hills Business Tower in Tokyo and the other in a souvenir shop in Hiroshima. This method of selling oysters is a first for Japan but in France, Belgium, and more recently, in the Netherlands, such machines are already in existence.

Consumers are able to obtain fried oysters, raw oysters on the half-shell, and raw tiger shrimp from the machines, complete with microwave to reheat the fried oysters. Of interest to note is that these are Claire oysters, a type of oyster finished in “Claire ponds,” or former salt-evaporation ponds. During January to April, the oysters eat a species of green algae that grows in the ponds, turning their gills green and imparting a sweet flavour to its meat. The method imitates one used for centuries in the Marennes-Oléron region of France.

**Partnership on cell-based seafood**

USA/Japan – BlueNalu, which produces cell-cultured seafood, is partnering with multinational sushi restaurant operator Food & Life Companies (F&LC) to develop an alternative to bluefin tuna belly (known as toro in Japan) and other sushi-grade products. The latter operates brands such as Sushiro and Kyotaru, with over 1 000 restaurants across Japan, Korea, Taiwan, Hong Kong, Singapore, Thailand and mainland China.

“Cell-cultured seafood is a supply-chain solution that will have the taste, texture and nutrition that consumers expect, and will not be susceptible to environmental contaminants like mercury and microplastics,” said BlueNalu CEO Lou Cooperhouse. “With the uncertainty of natural marine resources in the future, it is important that we secure a stable supply of seafood in a more sustainable manner,” said Koichi Mizutome, CEO of F&LC.

US-based BlueNalu already has an agreement to introduce cell-grown seafood in Europe. The company is also working with Mitsubishi, Pulmuone, and Thai Union, which owns the Chicken of the Sea brand, to bring cell-cultured fish to Asia. Cell-grown seafood products will also have to overcome regulatory hurdles.

**New financing facility for Asian aquaculture**

Asia - ADM Capital Group (Hong Kong), IDH - the Sustainable Trade Initiative (Indonesia), and Alune Aqua (Indonesia) have received a grant to develop what they say will be a blended finance solution called the Asia Aquaculture Facility (AAF). The grant was awarded by Convergence through the Asia Natural Capital Design Funding Window, co-designed with, and funded by the Hong Kong-based RS Group. When established, the AAF is envisaged to use a revenue-based financing model for farmers to engage in sustainable intensive aquaculture in Asia and support mangrove conservation. Currently, many farms follow traditional semi-intensive practices with limited yield, making sustainable aquaculture intensification a far-off prospect.

A pilot project will be launched in Indonesia with a focus on shrimp aquaculture, and with the possibility of other projects in India, Vietnam and the Philippines at a later stage. It is envisaged to improve some 5 000 livelihoods by increasing productivity, support the regeneration of 500 ha of mangrove, and the protection of 1 800 ha of mangrove forest.
Finding a use for shrimp head wastes

The Philippines - A team at the National Fisheries Research and Development Institute (NFRDI) has reported success in converting shrimp head waste into a nutrient-rich powder which can be used for seasoning of soups and other foods.

In its website report, the NFRDI says that in a shrimp processing plant, the shrimp’s head is typically discarded along with its shells and tails. The waste makes up 50 percent of the raw material, which means almost half of the money spent goes down the drain already. Improper disposal of these wastes may cause harm to the environment due to their nutrient-rich properties.

By turning shrimp heads into powder, food processing manufacturers will not only cut down their wastage but, more importantly, earn profit from otherwise discarded materials.

According to Rosa Bassig, Senior Science Research Specialist of the Fisheries Postharvest Research and Development Division of NFRDI, about 200 g of powder is produced per one kilogram of fresh shrimp heads. Not bad for business, considering that what would have been just a waste was converted into something valuable. The powder can be used as shrimp flavour seasoning, or in seafood broths, or soups, among others. Moreover, it has a storage life of up to six months when stored at 28-30°C based on a study published in The Philippine Journal of Fisheries.

New alternative protein facility set up

Singapore – On 17 February 2022, The Straits Times of Singapore reported the launch of a new pilot facility that uses Hermetia illucens (black soldier fly) larvae to process palm oil organic wastes into frass for use as plant fertilisers. The larvae themselves will also be integrated into shrimp feeds for aquaculture.

Set up by Singapore-based alternative protein start-up Inseact, the facility will be supplying local farms with the fertiliser in support of the country’s goals to produce 30 per cent of its nutritional needs by 2030. A much larger facility, to be built in neighbouring Malaysia, is in the pipeline as Singapore itself does not produce palm oil wastes.

Inseact joins another major local startup called Insectta which was set up in 2017. The latter uses black soldier fly larvae to convert wastes from soybean factories and breweries.

IPNLF launches Sourcing Transparency Platform

The International Pole and Line Foundation (IPNLF) has launched its Sourcing Transparency Platform (STP), an online portal designed to increase transparency in the tuna supply chain.

The STP is exclusive to IPNLF member-companies and aims to improve transparency of pole-and-line, handline, and troll (collectively known as one-by-one) tuna supply chains through public disclosure. The organization’s aim is to promote these fisheries at no cost to help increase their market access, and to promote responsible business practices of companies and educate consumers on responsible, ethical tuna products.

“Purchasing tuna products that are responsibly and sustainably caught has powerful social and economic benefits, as well as protecting the health of marine ecosystems,” IPNLF Social Responsibility Director Zacari Edwards said in a press release. “This is why increased transparency throughout supply chains is crucial to empower both consumers and industry to make more responsible choices that benefit both the ocean and coastal communities. The STP is a unique tool in this sense as it makes the direct connection between products and the fisheries where the tuna has been sourced from, guiding more-responsible tuna-purchasing practices as a result.”

According to the IPNLF, small-scale one-by-one tuna fisheries produce up to 50 times more labour per ton of tuna caught than industrial fishing, creating more equitable distribution of economic benefits and it recirculates the wealth among coastal communities that depend on the fishing industry, which in turn, contributes to local food security, poverty alleviation, and secure livelihoods.

For further information, see: https://sourcingtransparencyplatform.org/

Enhanced remote audit approach becomes effective on 7 March

MarinTrust, formerly known as IFFO RS, is the world’s leading independent business-to-business certification programme for the production of marine ingredients. In 2021, half of all the fishmeal and fish oil produced globally are MarinTrust-certified. According to a press release dated 7 February 2022, as of 7 March, MarinTrust will allow new applicants and high-risk facilities to be audited on a partially remote basis via an ‘enhanced remote audit’. This is because with the ongoing COVID infections globally, the need for remote auditing continues.

In the enhanced remote audit, the experienced MarinTrust approved
auditor will lead and conduct the audit on a fully remote basis. A local auditor, that is an ICT trained professional meeting the requirements outlined in the ‘Enhanced Remote Audit Guidance’, will attend the audit onsite with the main duty of giving support to the lead auditor as their “eyes, nose and ears”.

Maintaining a physical third-party presence during the enhanced remote audit mimics as much as possible a fully onsite audit and provides assurance to stakeholders that the integrity and robustness of the programme is upheld.

WWF says ocean plastic pollution will quadruple by 2050

A new report “Impacts of plastic pollution in the oceans on marine species, biodiversity and ecosystems” commissioned by WWF provides the most comprehensive account to date of the extent to which plastic pollution is affecting the global ocean, the impacts it’s having on marine species and ecosystems, and how these trends are likely to develop in future.

The report by researchers from the Alfred Wegener Institute Helmholtz Centre for Polar and Marine Research (AWI) reveals a serious and rapidly worsening situation that demands immediate and concerted international action. The summary of its findings are:

● Today almost every species group in the ocean has encountered plastic pollution, with scientists observing negative effects in almost 90% of assessed species;

● Not only has plastic pollution entered the marine food web, it is significantly affecting the productivity of some of the world’s most important marine ecosystems like coral reefs and mangroves;

● Several key global regions – including the Mediterranean, the East China and Yellow Seas and Arctic sea ice – have already exceeded plastic pollution thresholds beyond which significant ecological risks can occur, and several more regions are expected to follow suit in the coming years; and

● If all plastic pollution inputs stopped today, marine microplastic levels would still more than double by 2050 – and some scenarios project a 50-fold increase by 2100.

WWF is calling for a new global treaty on plastics which must be binding and contains specific, clear and universally applicable rules and obligations across the lifecycle of plastics that allow for an effective response to the global plastic pollution crisis.
INFOFISH organised a virtual training programme entitled Marine Fin Fish Hatchery Operations, Grow-out Farming and Health Management during 19-20 January 2022. Ms Shirlene Maria Anthonysamy, Director, INFOFISH, who opened the training session, welcomed the participants. She conveyed appreciation to the resource persons, Dr Jose Domingos, Associate Professor and Principal Research Fellow Aquaculture, Centre for Tropical Fisheries and Aquaculture, James Cook University Singapore; Mr. Chin Chiu Lin (Alex Lin), Chief Technical Officer and Project Manager, Thethis Corp. Taiwan; and Dr Kua Beng Chu, Director, Fisheries Research Institute, National Fish Health Research Division, Department of Fisheries, Malaysia, respectively. She also expressed gratitude to Mr V Subba Raju Penmetsa, a seabass farmer from India and Mr Donnie Chen, a grouper farmer from Malaysia, who participated in the ‘Meet the Farmer’ session and shared their practical insights among the trainees through interactive questions and answers.

In her opening speech, the INFOFISH Director underlined that although Asia is contributing the highest (42%) in global aquaculture production there is still an urgent need for reliable supply of quality seed, as well as expertise on modern farming techniques and fish health management. More partnerships and investments, species integration, technical expertise, national policies considering environmental issues, research and outreach are expected to unlock the full potential of sustainable mariculture development in the region.

The two-day training programme was divided into three sessions comprising hour-long technical presentations by each speaker followed by a Q & A Session for 30 minutes. This was followed by a 30-minute ‘Meet the Farmer’ session. On Day 1, Dr Jose Domingos started the training with his presentation entitled Operation and management of a commercial seabass hatchery where he discussed seed quality, life cycle, broodstock and larval rearing, mass spawning techniques, hatchery and larval feed management of seabass. His second technical presentation was entitled Commercial farming and management of a barramundi farm where he discussed seabass production in ponds, cages and RAS facilities, water quality, feed and management of seabass farms. Finally, Dr Kua Beng Chu spoke about Health management of farmed seabass, focusing on major infectious and non-infectious diseases, and management of farmed seabass through vaccine and alternative medicine (herbal products).

On the closing day, Mr. Alex Lin offered a technical presentation entitled Operation and management of a profitable grouper hatchery where he discussed the basic components of quality marine finfish hatchery facilities (hardware), key activities in a finfish hatchery (software), and the human characteristics (people). He continued with a second technical presentation, this time on Operation and management of a profitable grouper farm where he discussed the quality criteria for grouper fingerlings, as well as pre-grow out and grow out farm management of groupers. Finally, Dr Kua Beng Chu presented on the Health management of farmed groupers focusing on major infectious and non-infectious diseases, and control measures for major grouper diseases.

The virtual training was organised in response to requests from INFOFISH Member Countries on addressing challenges in the mariculture sector. Following completion of the training session, it is expected that participants will have a better understanding of the basic spawning techniques, farming methods and health management of two high value marine fin fishes e.g., seabass and grouper.

The training was participated by more than 45 people including government officials from Ministries and Departments of Fisheries, researchers, aquaculturists, hatchery technicians, INGOs/NGOs and the private sector from Bangladesh, Brunei, Cambodia, Fiji, Italy, Malaysia, Singapore, Maldives, Pakistan, Philippines, Sri Lanka and Thailand. They were awarded with certificates at the end of the training course.

Some snapshots of the participants during the training course
IMPLEMENTING THE PAPUA NEW GUINEA FISHERIES STRATEGIC PLAN 2021 – 2030 (FSP)

The Papua New Guinea National Fisheries Authority (NFA) recently concluded a two-day consultative workshop from 22-23 February 2022 at the Hilton Hotel in Port Moresby, Papua New Guinea under the theme ‘Holistic Tuna Fisheries Development; How do we do it?’

This was a meeting of key Government, industry and private sector stakeholders to encourage greater visibility, ownership and participation in terms of the overarching implementation of the recently launched Papua New Guinea Fisheries Strategic Plan 2021-2030. The focus of the Plan is on sustaining and advancing the vital tuna industry in Papua New Guinea, which is a significant mainstay of subsistence and semi-subistence livelihood, employment, foreign currency exchange and revenue from the rural or village-based fisher folk to the large-scale fishing industry and to the national economy.

Mr. Justin Ilakani, Acting Managing Director of NFA, addressing the participants

This consultative workshop was very timely, coming off the back of the launching on 25th August 2021 (last year) of the inaugural sector-wide PNG Fisheries Strategic Plan 2021-2030 (FSP). Launched by the PNG Prime Minister Hon. James Marape and the Minister for Fisheries and Marine Resources Hon. Dr. Lino Tom, the long-term development goal and mission of the FSP is that “Papua New Guinea’s fisheries sector is developed into a strong, broad-based, diversified and value-adding industry that is globally competitive; domestically inclusive and functioning as a robust and sustainable source of government revenue, food and livelihood for the people”. The FSP aligns to and cascades from PNG’s national planning framework from the ‘Constitution and Directive Principles’ to ‘Vision 2050’ and to the present Government’s priorities to encourage greater participation and growth in the sector.

PNG FISHERIES STRATEGIC PLAN’S KEY RESULT AREAS (KRAS)

As highlighted in the NFA’s Acting Managing Director Mr. Justin Ilakani’s presentation, the FSP at its heart has eleven Key Result Areas (KRAs) for the sector as a whole to contribute to from their respective business points in advancing the vision and mission of the Plan:

- Development of Enabling Infrastructure and Improvement of Industry Operating Environment
- Optimisation of Government Revenue
- Increases in Downstream Processing, Value Adding, Employment and Export Earnings
- Expanding and Enhancing of International Trade and Market Access for Fisheries Products
- Supporting, Maintaining and Encouraging of Genuine Foreign Direct Investment Inflows
- Optimisation of Papua New Guinean Participation and Local Content in the Fisheries Sector
- Improvement in Food Security and Livelihood Opportunities
- Strengthening of Research, Development, Extension Support Services, Training and Capacity Building
- Maintaining and Strengthening Sustainable Fisheries Management and Healthy Ecosystems
OBJECTIVES OF THE WORKSHOP
Throughout the consultative workshop, various speakers presented further on the FSP’s priorities and outcomes, as well as the opportunities and challenges for the sector as a whole in working to implement and realize these KRAs. Throughout the two days of the consultation, participants looked at the following objectives/goals as a basis for consultation and action working forward.

Objective 1: Sustainable fisheries management and development
Presentations and discussions focused on sustainable tuna fisheries management and its development, as well as the better management of purse seine fishing efforts in PNG and the waters of the Parties to the Nauru Agreement (PNA) under the Vessel Day Scheme (VDS), and PNG’s initiative aimed at increasing the volume of tuna processed by PNG-based processors through the Fisheries Rebate Scheme.

Objective 2: Status of tuna fishing and processing - the way forward
Tuna fishing and processing representatives provided important updates on their operations and highlighted issues and challenges facing the sector. Highlights in this session were the presentations by the PNG Fishing Industry Association (FIA) on the industry’s performance as holder of the Marine Stewardship Council certification for all tuna catches within PNG waters. The PNG FIA utilizes the Integrated Fisheries Management System (IFIMS) in ensuring real-time monitoring for traceability throughout the supply chain and the chain of custody. Presentations also referred to programmes that the industry was putting in place such as “social responsibility and human rights welfare on board fishing vessels” and “marine litter and fishing gear mitigation and management”.

Objective 3: Enabling environment for a viable industry
The Pacific Islands Forum Fisheries Agency (FFA) provided an update on the push by the Pacific Island Leaders to establish tuna fisheries regional processing hubs as a vehicle to support growth in the region. The head of the European Union Delegation to PNG highlighted the latest policies on market access to the European Union market, followed by contributions from the national government departments and agencies on their respective roles in facilitating investments, ensuring access to markets and providing services which contribute to a better enabling environment for a viable tuna fishing and processing industry.

Objective 4: Environment, capacity development and technology issues
Environment, capacity development and technology are important considerations for the tuna industry. Discussions were centered on what the Government, through the National Fisheries Authority, was doing to provide appropriate training and capacity building in fishing and post-harvest and also looked at the use of technology in fisheries management as well as in fishing and the management of fishing fleets.

CONCLUDING POINTS OF THE CONSULTATION
The critical take-home message from the consultation meeting was the need for greater dialogue and collaboration by all stakeholders and a whole-of-government approach that is essential in creating a conducive policy and business environment that is enabling, as well as greater or more viable incentives necessary in garnering more investments in the fishing industry and the sector as a whole for Papua New Guinea.

From an economic, social and sustainable viewpoint, the sector’s approach as a whole to the FSP in the form of a concerted and collaborative effort, is a must by all stakeholders and partners. As is the case, continuing dialogue and stakeholder consultations must be at the fore and are crucial in creating awareness of the objectives of these strategic plans, as well as harnessing the necessary and required collective efforts over the ten-year period of its lifespan. This consultative workshop was an opportunity to commence such dialogue and conversations, in bringing together representatives from the government departments and agencies including participants from the regional offices and key development partners, together with senior officials of the NFA to meet and discuss with managers and operators of the tuna fishing fleets and processing plants in Papua New Guinea, with the view to highlight and carry through on practical initiatives and interventions as necessary in working forward.

This being so, the PNG Government’s vision through this Plan and other regulatory frameworks will ultimately work to ensure that community aspirations and means of livelihoods are promoted and protected, that industry is encouraged to grow, and that it remains a sustainable and viable industry, now and into the future, for the benefit of all.

Transshipment at Simpson’s Harbour in Rabaul, East New Britain Province, Papua New Guinea
ACHIEVING RESILIENCE AND SUSTAINABILITY IN THE SEAWEED INDUSTRY IN MALAYSIA

By Phaik-Eem Lim, Sze-Wan Poong, Cicilia S.B. Kambey, Ji Tan and Azam Asri

The carrageenophytes Kappaphycus and Eucheuma are carrageenan-producing tropical red seaweeds cultivated on a large scale in Malaysia. Analysis of the carrageenan value chain has shown that the production and export of these seaweeds have declined in recent years. Challenges to the growth of the industry include climate change, inconsistent supply of healthy seedlings, the need for more inclusive governance, the lack of innovation and dedicated research and development (R & D), as well as inadequate farm biosecurity management measures and poor coordination in downstream marketing. Recommendations are provided for the long-term economic development and sustainability of Malaysia’s seaweed aquaculture industry.

Seaweed culture contributes to the livelihoods of small-scale fishers in Malaysia

The cultivation of carrageenophytes Kappaphycus and Eucheuma plays a very important socioeconomic role by supporting the livelihoods of remote coastal communities in the country. In year 2020, a total of 182,043.30 metric tonnes wet weight of carrageenophyte seaweeds were produced in Malaysia, contributing a revenue of over US$14 million for the country.

Seaweed aquaculture in Malaysia (Figure 1) started during the 1970s along the east coast of Sabah, where Kappaphycus and Eucheuma (Figure 2), also collectively known as eucheumatoids, were cultured using traditional monoline methods. The importance of seaweed cultivation has been recognised by the Malaysian government since the 1980s, and various aquaculture programmes, incentives and initiatives have been introduced to boost seaweed production.
Implementation of these programmes resulted in a general increase in seaweed production until 2012, when a peak output was recorded. However since then, the seaweed production and value in Malaysia have generally been declining (Figure 3).

In order to rejuvenate the seaweed aquaculture industry in Malaysia, there is an urgent need to understand the challenges and risks faced by the industry so that appropriate measures can be carried out to ensure its resilience and sustainability. Malaysia’s involvement in the GlobalSeaweedSTAR (GSSTAR) program (2019-2021) funded by the UK Research and Innovation (UKRI) Global Challenges Research Fund1 was timely, given the problem-based multidisciplinary approach adopted to address issues affecting seaweed cultivation and processing industries throughout the globe. These include the detection of diseases and pests associated with seaweed farming, farm management, national policy and legislation, conservation and exploration of genetically diverse seed stocks, and socio-economic resilience of the industry.

Research findings in addressing the challenges and risks within the seaweed aquaculture industry

The research team at the University of Malaya (Universiti Malaya) employed a multi-faceted approach based on fieldwork, key informant interviews, secondary data, and laboratory-based experiments which aimed to identify the key gaps linked to decline in production, and to propose specific measures to invigorate the local seaweed industry.

Pests and diseases

According to our survey with seaweed farmers in Sabah, disease and grazing pressure are the main challenges faced in their farms with 60% of farmers in Semporna, the largest production area, reporting premature harvest as a countermeasure. Ice-ice disease (IID), infestation by epiphytic filamentous algae (EFA) (Figure 4) and turtle grazing are the common disease and pests reported locally. Recurring IID and EFA infestation has led to shortage of healthy propagules for replanting and farmers have had to reuse infected crops to restock their farms.

IID is characterised by crop bleaching and softening which leads to fragmentation, loss of biomass and reduced carrageenan yield and quality. IID is generally attributed to unfavourable changes in environmental conditions such as the increase in seawater temperature and reduced seawater salinity; as such, incidences of IID are expected to worsen in severity and frequency with climate changes observed in the

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1 GlobalSeaweedSTAR (https://www.globalseaweed.org) is a four year, challenge-led programme (1 Oct 2017 to 31 Dec 2021) funded by the Global Challenge Research Fund (BB/P027806/1) of UK Research and Innovation (UKRI). The programme brings together an international team of experts in science, policy and economics from nine partner institutions across the United Kingdom, Philippines, Malaysia, Tanzania and Canada.
tropics. When the crops are in distress, their susceptibility to secondary microbial infections increase.

Our on-farm study also found that *Kappaphycus alvarezi*, the most dominant eucheumatoid cultivar worldwide, is more disease-resilient compared to *K. malesianus* (Figure 2), while previous studies noted the higher resistance of *E. denticulatum* to epiphyte infestation compared to *Kappaphycus* species. DNA barcoding of the EFAs found that at least two species of *Melanothamnus* (previously known as *Polysiphonia* or *Neosiphonia*) are the dominant pests of *Kappaphycus* and *Eucheuma*, and these EFAs caused more damage via penetration into the host cortical tissues compared to other loosely attached epiphytes which can be easily removed through regular farm maintenance.

Several measures were proposed to minimise the occurrence of pests and diseases in eucheumatoids, which include: (i) real-time monitoring of critical environmental parameters and an early warning system via the use of Internet of Things (IoT) sensors; (ii) developing a model for data-driven siting of farms based on long term GIS data on climate, oceanographic patterns and turtle migration routes; (iii) developing a rapid test kit for EFA detection based on DNA barcode data; (iv) implementing on-farm biosecurity management measures (see section on “Weakness in national seaweed biosecurity frameworks”); and (v) developing disease and climate-resilient cultivars from the assortment of indigenous natural populations (see next section on “Low genetic diversity within cultivars”). Data analysis on the associated microbiome of healthy and diseased crops is currently underway and is expected to provide useful insights into the changes of seaweed microbiome during a disease outbreak.

**Figure 4: Common disease and pests in eucheumatoids**

(A) ice-ice disease (IID); (B) epiphytic infestation

**Low genetic diversity within cultivars**

Since the 1970s, farmers have mostly relied on vegetative cuttings as their source of seedlings. The repeated use of asexual propagules and limited genetic diversity within cultivars has inadvertently led to decreased seedling vigour and resilience. Consequently, this scenario has resulted in an increased susceptibility to disease and pest infestation. Findings from the current study indicate higher genetic diversity within natural populations relative to cultivated seaweeds, which imply that potential new sources of cultivar with better resilience to disease, pest and climate changes can be developed from this pool of native natural populations (Figure 5).

**Figure 5: Overview of the identification, selection and development of new eucheumatoid cultivars**

Nonetheless, it is equally important to step up efforts in conserving these valuable resources before they are wiped out by extreme weather, habitat degradation, or other human disturbances. It is worth noting that *Kappaphycus alvarezi*, which was first described in Sabah, has not been found in the wild in Malaysian waters since 2010.
Several measures that can be implemented include developing new cultivars through sexual propagation of reproductive individuals collected from the wild; establishment of a biobank for repository and long-term maintenance of genetically diverse seaweeds; and setting up dedicated nursery facilities to ensure quality control and traceability of source, in addition to all-year round availability of stocks for farming. As genomic data of commercially important species becomes more readily available, cultivars with desirable traits such as fast growth and disease resistance can be developed through genetic marker-assisted studies.

**Weakness in national seaweed biosecurity frameworks**

Various biosecurity strategies adapted in an aquatic aquaculture system have been widely used to prevent, control and manage seaweed aquaculture risks and all consequences ranging from disease and pathogens to production and economic trade risks. In general, biosecurity involves practices, procedures, and policies/regulations from which effective strategies can be applied at the farm, regional, national or international levels.

Malaysia is one of the few eucheumatoid producing countries which has developed seaweed aquaculture frameworks incorporating a biosecurity concept within its national regulations to manage aquaculture risks, and these are governed by the Department of Fisheries Malaysia (DoF) as the national competent authority. Using the Knowledge, Attitude, Practices (KAP) survey technique; an evaluation of the seaweed biosecurity frameworks which includes the national legislation of Fisheries Act 1985, the Malaysian Good Agricultural Practices (MyGAP 2014), Malaysian Standard MS 2467-2012; and a seaweed farming manual for *Kappaphycus/Eucheuma* published by DoF, it was found that these regulations and guidelines were poorly communicated to, and adopted by, the farmers. At the national level, there is no quarantine system available to prevent introduction of disease and pests from the movement of live seaweeds. As a result, about 80% of farmers in the most productive region of Semporna and Kunak, have not implemented quarantine procedures for their seaweed crops. In addition, an insufficient disease surveillance system has led to 75% of farmers never reporting on-farm disease outbreaks to the government, and risk assessment has not been included in the current national seaweed aquaculture policies and regulations. At the farm level, crop management measures have been inappropriately practised by farmers due to unclear and inexplicit instructions in the seaweed biosecurity frameworks.

Challenges that need to be addressed are: (i) conducting evidence-based experiments which demonstrate the success of biosecurity measures in either mitigating or minimising biosecurity risks to strengthen policy recommendation; (ii) official registration of farmers as well as farm certification programmes need to be rigorously implemented for all farm scales, including small-scale individual farmers and private companies to ensure adequate and standardised practices; (iii) establishing a national database for reporting incidences of disease/pest/pathogens that is accessible to every stakeholder in the industry; and (iv) there is a need to develop a quarantine system at the national and regional levels.

**Lack of coordination in the Malaysian seaweed value chain**

Government intervention in seaweed farming activities has brought positive impact in increasing the annual production, despite a decline in production since 2012. However, our study found that government policies generally place more focus on upstream activities with less attention being given to marketing and downstream activities (Figure 6). Although carrageenan-processing factories were established in Malaysia in the early years of the industry, they ceased operation by 2020 owing to dwindling cost effectiveness. As a result, some seaweed farmers are forced to sell their production to neighbouring countries when there is less demand from local companies. This outflow affects the local seaweed value chain.

The current value for the global seaweed industry is US$7 billion, whereby US$6 billion is traded for human consumption and US$1 billion traded as by-products including hydrocolloids, fertilisers, bioactive compounds and animal feeds. Besides carrageenan, other potential high-value markets for *Kappaphycus* seaweed are for plant biostimulants, environmentally friendly packaging (bioplastics), and human health products. The seaweed aquaculture industry in Malaysia can be better sustained by diversifying seaweed-based products which will in turn increase the demand for seaweed and boost the local production.

Price instability of dry seaweed is also one of the issues faced by seaweed farmers. The buying process between farmers and buyers is dominated by intermediaries who have the power to set a lower price. As such, the income of seaweed farmers is volatile, which deters their interest in farming seaweeds and in turn affecting seaweed production in Malaysia. To minimise the adverse effects of price fluctuations, collecting centres or
marketing and sales facilities can be set up by the government so that farmers can sell their crops at a reasonable price or at least the floor price. This initiative can be undertaken by the Farmers’ Organization Authority (Lembaga Pertubuhan Peladang) or other organisations that have the experience and facilities to set up the collecting centres.

**Figure 6: Malaysia’s seaweed value chain**

**Value Chain Players:**
- **Farming activities**
- **Harvesting**
- **Drying**
- **Marketing and trading**
- **Processing & exporting**

**Value Chain Influencers:**
The seaweed industry in Malaysia is regulated by the Department of Fisheries Malaysia (DOFM) and Sabah Fisheries Department (SFD).

**Value Chain Supporters:**
The main supporters in the Malaysian seaweed value chain include (i) Standard and Industrial Research Institute of Malaysia (SIRIM), (ii) Malaysian Agricultural Research and Development Institute (MARDI), (iii) University sector and (iv) Sabah Fisheries Department (SFD).

**Importance of Research and Development (R&D)**

Despite the decades-long history of the seaweed aquaculture industry in Malaysia, R&D is still in its infancy, particularly in the upstream process of breeding to improve seedling vigour via sexual reproduction. Innovations in farming technology such as seeding, harvesting and drying are necessary to improve production and quality of the crops. Involvement of R&D in the seaweed value chain is essential to improve existing farming procedures such as disease management, and also at the downstream level such as formulating standards for product quality, ensuring price stability, as well as diversification to generate demand for seaweed products by the local market and for export.

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FRESHWATER EEL INDUSTRY PRACTICES IN THE PHILIPPINES

By Francisco F Santos, Jerwin G Baure, Mary Nia M Santos, and Lilian C Garcia

Eel farming, which contributes over 90% of all Anguilla production worldwide, is dependent on growing out wild-caught juvenile (or glass) eels. While the culture and trade of temperate Anguilla species is well established, less is known about tropical species. This article is based on a study conducted by the authors, the findings of which have been compiled in a manual entitled “Freshwater Eel Culture Industry Practices in the Philippines”. This is the first such manual to document and present the different culture systems, industry practices, and problems associated with the country’s eel farming sector.

Freshwater eels of the family Anguillidae are considered one of the economically-important high-valued species worldwide, especially in the East Asian countries. In the Philippines, A. marmorata and A. bicolor pacifica are the most abundant and widely cultured (Aoyama et al., 2015; Silfvergrip, 2009). The culture of eels is well developed in several neighbouring countries, such as Taiwan and Japan, based on the requirement of temperate eels such as A. japonica and A. anguila. However, to date, little is known regarding the culture technologies applicable in the rearing of tropical eels such as A. marmorata and A. pacifica bicolor.

World demand for freshwater eels has been increasing due to the market expansion and increased popularity of several eel dishes, such as kabayaki. In the Philippines, eels have become an important export commodity.

Flow of trade in the Philippine anguillid eel industry

Before the implementation of the Fisheries Administrative Order (FAO) 242 in 2012 which banned the export of freshwater eels of sizes smaller than 6 inches, prices for glass eels reached as high as PhP 55 000.00 per kg (BFAR, 2012). In 2013, after implementing FAO 242, the Philippines exported 88 161.10 kg worth USD 615 173.92 to countries such as Japan, Taiwan, and Korea (Figure 1). However, production drastically declined by almost 30% the following year. In 2016, the production volume reached only 39 752.40 kg worth USD 254 164.67 (BFAR-OSEDC, 2017). This decline in production has been attributed to financial constraints, operational failures and high mortality.

Figure 1: Volume and value of freshwater eels exported from the Philippines from 2013 to 2016

Several people are involved in Anguillid eel marketing in the Philippines. From the collectors, the market channel goes through stockers, consolidators, growers or traders, suppliers, and exporters before it reaches the consumers. In a study¹ conducted by the authors under the Department of Agriculture, National Fisheries Research and Development Institute.

Institute (NFRDI), the country’s major glass eel collection sites were identified to be in Cagayan, Davao, General Santos, and Cotabato. Other collection areas included Lanao del Norte, Misamis Oriental, and Zamboanga. The majority of the eel nursery and grow-out farms visited obtain glass eels from Cagayan, followed by Davao.

Figure 2: Major glass eel collection sites (in yellow) in the Philippines

The country’s major glass eel collection sites were identified to be in Cagayan, Davao, General Santos, and Cotabato (Figure 8). Other collection areas include Lanao del Norte, Misamis Oriental, and Zamboanga. The majority of the eel nursery and grow-out farms visited obtain glass eels from Cagayan, followed by Davao.

The marketing channel starts with glass eel collectors, usually composed of the local communities along the rivers. The commonly used fishing gears are scoop nets (*sibut*) and filter nets (*tangab*). Scoop nets are small hand-operated fishing gears formed like bag nets and, as the name implies, used to scoop fish out of the water. A filter net is a stationary fishing gear made of post and netting panels that form a conical bag. The mouth of the filter net is set facing the current flow. The farthest end of the conical bag is where the fish is trapped and caught.

The glass eels are then bought by a stocker, who sells them to consolidators who are involved in the gathering of glass eels from several provinces or regions. They provide the necessary materials and supplies such as fishing gears, lamps, and oxygen tanks to glass eel collectors. The consolidators are also involved in the reconditioning and packaging of glass eels prior to transport to growers.

The glass eels are packed at around 150 to 200 g per plastic bag. The plastic bags are then oxygenated and kept at low temperature until transportation to growers. They provide the

2 The biggest consolidator in General Santos and Sarangani is female. In Cagayan, two out of the five consolidators are female. However, males dominate the workforce in the culture of eels. Female involvement in culture may include supervision and household chores, although several female technicians are also in a few eel culture facilities.
temperatures. Glass eels can be transported either by land, sea, or air. Conditioning of the glass eels is necessary before transport. Transport should be done in the evening, early in the morning or late in the afternoon when it is cooler, to reduce stress during transport. Glass eels are handled with utmost care to avoid mortality. No feed is given 24 hours before transport to empty the fry’s stomach, and the water is changed in the holding tanks. The eel fry is packed in double-lined plastic bags filled with fresh water at a density of 6,000-6,500 pcs, which is approximately 150-200 g per bag. Oxygen is supplied into the bags, and the bags are securely tied with a rubber band.

Then, the growers or traders culture the glass eels to the kuroko (juvenile) stage for about 6-8 months until they reach the standard size of 6 inches (approximately 15 cm). After the culture period, growers or traders may opt to (i) Culture kuroko to a table size of 200 g, then sell to local institutional markets and processing plants; (ii) Sell kuroko to exporters who have direct contact with buyers abroad; and (iii) Sell kuroko to foreign buyers if they have direct connections.

Several restaurants, particularly Japanese and Korean outlets in Metro Manila and Pampanga, buy eels from eel growers. There is only one eel processing plant in the country, located in Cabadbaran City, Agusan del Norte.

**Marketing**

The price of glass eels and juvenile eels (kuroko) is most often dictated by the buyer, although negotiations are done in several instances. Prices of glass eels vary per season, depending on supply and demand. Although glass eel supply is stable throughout the year, the species composition determines its price. There are instances of “no buying” season due to very low *A. bicolor pacifica* composition, the species which buyers prefer. However, since data on seasonal species composition are lacking, cases of overpricing occur. The buying price of glass eels from collectors and stockers ranges from as low as PhP 500.00 to PhP 8,500.00 per kg. Consolidators will then sell glass eels from PhP 3,500.00 to PhP 25,000.00 per kg, depending on species composition.

After 6-8 months of culture, kuroko (*A. bicolor pacifica*) may be sold directly abroad or sold to other grower-exporters. The legal size for export is 6-7 inches, weighing approximately 6-7 g or 150 pieces per kg. It is practiced in the industry that if a certain grower or exporter is unable to reach the minimum

Differences in dorsal fin length and body markings of *A. marmorata* (top) and *A. bicolor pacifica* (bottom). These are the most widely cultured eel species in the Philippines.
volume for export, the grower or exporter may buy kuroko from other growers. The buying price is PhP 24.00-35.00 per piece. The cost of *A. marmorata* is 60% lower than *A. bicolor pacifica*. The major market for kuroko is Japan, followed by Taiwan and Korea. China is also a market, although in small volumes.

**Problems and challenges of the industry**

The eel industry is facing a lot of problems from collection until export. These problems must be addressed to help the rising sector.

Species composition has always been a problem among collectors, consolidators, and growers since *A. bicolor pacifica* is the preferred species in the market. Due to the limited availability of glass eel species identification methods, buyers and consolidators often find it difficult to deal with glass eels, especially when *A. bicolor pacifica* composition is low during that season. Aside from its low market preference and value, the study found *A. marmorata* to be easily stressed and prone to mortality, as well as having a slow growth rate. Thus, there is a “no buying” season whenever *A. marmorata* composition was found to be high.

Another problem is the fry quality. Several farms experience mortalities several days after stocking. This could be attributed to stress caused during transport and reconditioning. One way to avoid mortalities is to condition the glass eels before transporting them to growers.

There is also limited data on eel production and eel culture facilities available, which could help develop the industry. Several Bureau of Fisheries and Aquatic Resources and Municipal Agriculture Office (MAO) offices visited have limited data on glass eel and eel production. Philippine Statistics Authority’s data on the volume of production of eels is only on the municipal fisheries sector, not on aquaculture. Further action must be taken to address this lack of information in eel production.

*A. marmorata*, although of less consumer preference and value, is the most dominant freshwater eel species in the Philippines. Its price is about 60% lower than that of *A. bicolor pacifica*. If there is a limited market of this species abroad, a local market must be developed to utilise this resource.

Exporters also experience problems during export. Due to the implementation of FAO 242, *kuroko* of sizes smaller than 6 inches are banned from being exported. However, manual sorting of eels is prone to human error. Upon inspection in Customs, exporters were not allowed to export when a small percentage of eels not reaching 6 inches were found. This creates a problem among exporters since eels will get stressed during packing and transport. There is also a possibility of a loss of trust among foreign buyers. Thus, several exporters propose that there should be a percentage error provided for export. However, this matter must be discussed by stakeholders and the Bureau of Fisheries and Aquatic Resources (BFAR).
Peru joins INFOPESCA

We are pleased to inform that the Government of the Republic of Peru has approved its entry into INFOPESCA.

Approval of the draft legislative Resolution 219/2021 that proposes membership to INFOPESCA was granted during the Plenary of the Congress of the Republic of Peru in a session on November 16, 2021. Previously, it had been approved unanimously by the Foreign Relations Commission.

The amendment approved by the General Assembly will enter into force for Peru once the internal procedures for the improvement of treaties under national law are completed. This must be internally ratified by the President of the Republic through Supreme Decree.

INFOPESCA continues to work intensely to incorporate more countries in the region in order to complete the tasks and goals of our organisation.

Project: strengthening of sanitary policies in hydrobiological products of Peru

INFOPESCA participated in a project called “Strengthening Sanitary Policies in Hydrobiological Products of Peru” and whose main activity consisted of planning, organising and delivering nine virtual training courses for officials of the National Fisheries Health Agency of Peru (SANIPES).

The training carried out by INFOPESCA included the participation of a wide range of international consultants and experts in each of the topics.

The main objective of this technical assistance was to strengthen the capacity of the Agency in sanitary control based on risks, thus ensuring the safety of hydrobiological products exported worldwide. The technical assistance also consisted of the design of training materials and suggestions to the participants on the methodological tools discussed during the training course to apply to daily life tasks. The number of course participants was approximately 50 officials, selected by the Peruvian authorities.

The international organisation COWATER was a partner in this project funded by the Canadian Department of Foreign Affairs, Trade and Development for the benefit of the Trade and Development Expert Deployment Mechanism (EDM) in Peru.

The nine courses were:

1. Strengthening the competent fisheries health authority: The fisheries health authorities at the international level (USA, Canada, EU, Ecuador, Uruguay, Chile) gave presentations. A SWOT analysis was carried out on the fisheries health authority of Peru (SANIPES);

2. Value chain of fishery products and risks at each stage of production: Exports of Peruvian products to Canada/Anatomy and physiology of fish/Disease-causing agents in different products / The use of technology in sanitary control/Deterioration of fishery products;

3. Competence of fisheries inspectors in the different stages of the value chain: Examples and experiences of the countries of the region/Domestic market, export and import;

4. HACCP principles: Details of the different principles/HACCP in Peru/Experiences with regard to ships, markets, plants, transport.

5. Requirements for the entry of new products in the Canadian market: Sanitary, quality and ecological certifications;

6. Traceability of fishery products (sanitary and political): Operation and examples of traceability systems in different countries;

7. Alerts and notifications: Food notifications managed at three levels: alerts, information, rejections. Types of problems reported in various countries: Presence of foreign bodies, bacteria, substances not declared on the label or risk/hazard characteristics related to the food product;

8. Product testing and laboratory work: Development of a laboratory work protocol and experience in different laboratories. Virtual visit to an Italian laboratory and virtual visit to the SANIPES laboratory; and

9. Training for trainers: This course included all the previous topics with the intention of training SANIPES officials so that they can replicate the courses autonomously.

More relevant information about the courses will be published soon.
INFOFISH organised a virtual training programme entitled *Marine Fin Fish Hatchery Operations, Grow-out Farming and Health Management* during 19-20 January 2022, in response to requests from INFOFISH Member Countries.

The resource persons were Dr Jose Domingos, Associate Professor and Principal Research Fellow Aquaculture, Centre for Tropical Fisheries and Aquaculture, James Cook University Singapore; Mr. Chin Chiu Lin (Alex Lin), Chief Technical Officer and Project Manager, Thethis Corp. Taiwan; and Dr Kua Beng Chu, Director, Fisheries Research Institute, National Fish Health Research Division, Department of Fisheries, Malaysia. INFOFISH Director Shirlene Maria AnthonySam expressed gratitude to Mr V Subba Raju Penmetsa, a seabass farmer from India and Mr Donnie Chen, a grouper framer from Malaysia, who participated in the ‘Meet the Farmer’ session and shared their practical insights among the trainees through interactive questions and answers.

On Day 1, Dr Jose Domingos started the training with his presentation entitled *Operation and management of a commercial seabass hatchery* where he discussed seed quality, life cycle, broodstock and larval rearing, mass spawning techniques, hatchery and larval feed management of seabass. His second technical presentation was entitled *Commercial farming and management of a barramundi farm* where he discussed seabass production in ponds, cages and RAS facilities, water quality, feed and management of seabass farms. Finally, Dr Kua Beng Chu spoke about *Health management of farmed seabass*, focusing on major infectious and non-infectious diseases, and health management of farmed seabass through vaccine and alternative medicine (herbal products).

Before joining Eurofish he worked at DTU Food, a department at the Technical University of Denmark for several years with secondments to Japan and Australia. “I am greatly honoured by the trust placed in me by the representatives of the Governing Council and look forward to working with them and our other partners for the benefit of the fisheries and aquaculture sector in the Eurofish member countries”, said Marco, following the decision in his favour.

The International organisation for the Development of Fisheries and Aquaculture in Europe (Eurofish) is an intergovernmental organisation that contributes to the development of the fisheries and aquaculture sectors in Europe. The organisation’s flagship periodical, Eurofish Magazine, the Eurofish website, and other specialised publications are used to disseminate information and analyses of the sector to an international audience. The organisation also organises conferences, workshops, and seminars, and executes a variety of projects in the fields of post-harvest fisheries, processing, aquaculture, trade, and marketing.
The Equipment & Supplies section in this issue of the INFOFISH International features DNA extraction and analysis tools for use in ensuring safety, traceability of species; and to help to detect incidences of fraud due to deliberate mislabelling and substitution of species.

To ensure that food quality and safety standards are met, reliable and sensitive methods of analysis are essential. Biosensors fit this description and are typically designed for selectivity, specificity, sensitivity, usability, flexibility, low cost, and quick processing time. They can be enzyme-based, tissue-based, immunosensors, thermal or piezoelectric and they are used for measuring freshness, allergens, pesticides, heavy metals, pollutants, pathogens, adulterants and toxins.

DNA biosensors are especially useful in that they can provide proof of traceability and sustainability as well as detection of food fraud such as mislabelling and substitution with cheaper fish. These practices are especially hard to detect when fish is highly processed into prepared fish meals. In a study entitled “Fraud in highly appreciated fish detected from DNA in Europe may undermine the Development Goal of sustainable fishing in Africa” published online by Sci Rep in June 2021, 401 samples of fish highly consumed in Europe and worldwide (i.e. tuna, hake, anchovy, and blue whiting) were analysed through PCR-amplification and sequencing of a suite of DNA markers. Results revealed low mislabelling rate (1.9%) with a higher mislabelling risk in non-recognisable products. Furthermore, the use of endangered species as substitutes points towards illegal, unreported and/or unregulated fishing in African waters.

The USFDA’s publication “Single Laboratory Validated Method for DNA-Barcoding for the Species Identification of Fish” is especially relevant as a source of reference. It suggests Standard Operating Procedures for:

- Tissue Sampling
- Tissue Lysis and DNA Extraction
- Polymerase Chain Reaction - COI Amplification
- PCR Cleanup
- Cycle Sequencing Reaction
- Sequencing Reaction Cleanup
- Sequencing
- Post Sequencing Analysis

The following is a selection of DNA biosensor test kits, reagents and other supplies that are available on the market:

**Analyser Kit with 24 barcodes**

SGS All Species ID Food DNA Analyser Kits allow for labelling and amplification of meat, fish or plant DNA by PCR, thereby preparing the sample for Next Generation Sequencing, and automated data analysis by the SGS All Species ID Software. Test results provide a list of the meat, plant or fish species present in the sample. Each Analyser Kit is available in two different formats with 24 different barcodes each, enabling the researcher to label up to 48 samples at once for multiple simultaneous sample analysis.


**Handheld pen-shaped device**

The MasSpec Pen is an easy-to-use handheld device connected to a mass spectrometer that employs a solvent droplet for gentle chemical analysis of samples. Produced by a team of researchers from the University of Texas, the MasSpec Pen (roughly the length of a typical ink pen) was originally developed to detect tumours on contact but it was realised that if it could differentiate human tissue, the same could be done for other animals.

When the tip of the device is pressed against a sample, a 20-µL solvent droplet is released, thus extracting adequate amounts of molecules within 3 seconds for precise analysis through mass spectrometry. The entire process takes 15 seconds and avoids the need for pre-processing, while the liquid extraction does not damage the surfaces of the samples. The researchers have also created authentication models with the distinct patterns of the molecules detected, such as anserine, carnosine, taurine, succinic acid, and xanthine to differentiate pure meat types from each other, beef dependent on feeding habit, and among five fish species.
MasSpec Pen analysis was performed directly on several meat and fish types including grain-fed beef, grass-fed beef, venison, cod, halibut, Atlantic salmon, sockeye salmon, and steelhead trout, with a total analysis time of 15 s per sample.

The findings of the study have been reported in the *Journal of Agricultural and Food Chemistry* from the American Chemical Society. The team says that the tool provided answers about 720 times faster than a leading meat-evaluating technique called polymerase chain reaction (PCR) testing and that it was much easier to use. They are working on interfacing the device with a portable handheld mass spectrometer to make the technology more accessible and expand its use and speed up species identification. However, they caution that the MasSpec Pen is so new that the current database is limited to 12 markers for common fish, which is insufficient to deal with samples that could come from some 30,000 species.

Reagent for DNA analysis

Quantitative PCR (qPCR) and qRT-PCR reactions require reagents that are accurate and reliable. KAPA Express Extract is a thermostable protease and buffer system that allows DNA extraction from fish tissues, both fresh and processed, in about 15 minutes.

The extractions are performed in a single tube without the need for hazardous chemicals and multiple washing steps, thereby greatly reducing the risk of sample loss and contamination.

*Manufacturer: KAPA Biosystems Inc., USA (https://www.sigmaaldrich.com)*

Kit for rapid purification of total DNA

DNeasy Blood & Tissue Kits are designed for rapid purification of total DNA (e.g., genomic, mitochondrial, and pathogen) from a variety of sample sources including fresh or frozen animal tissues and cells, blood, or bacteria.

Purification requires no phenol or chloroform extraction or alcohol precipitation, and involves minimal handling. This makes DNeasy Blood & Tissue Kits highly suited for simultaneous processing of multiple samples. For higher-throughput applications, the DNeasy 96 Blood & Tissue Kit enables simultaneous processing of 96 or 192 samples.

*Manufacturer: Qiagen, USA (https://www.qiagen.com/products)*

And coming up: next generation DNA-based feed analysis

With funding from the Norwegian Research Council, Norway-based Orivo is working on a project to develop a quantifiable DNA-analysis method that will enable precise determination of the species composition in feed-related samples. It has a total budget of NOK 8.6 million (€810,000/US$990,000), and among the partners in the project is the Danish sustainable aquaculture feed producer, BioMar.

“‘The DNA-based analysis methods currently available in the market are either unreliable in terms of quantifiability or unable to detect unknown species present in a sample. With this project we aim to expand our existing analysis platform with a method that solves both these issues.’ says Orivo’s CEO Svein Erik Haugmo,

*Information: Orivo, Norway (http://orivo.no)*
In this issue of the INFOFISH International, our Innovations focus this time is on seafood analogues, both plant- and cell-based.

Seafood analogues are slowly but surely rising in popularity as more consumers look for alternatives to meat due to concerns over their own health, environment sustainability, and animal welfare. These analogues, based on plants or cell culture, mimic the texture and sensorial properties of fish-meat, seafood, or processed fish products through a variety of ways.

Confirmation of this rising market trend can be obtained from the US-based Good Food Institute (GFI)’s annual report for 2020 which stated that it was a “record period of investment” for alternative protein. The GFI report covers the plant-based, cellular agriculture and fermentation sectors. According to Bloomberg Intelligence, the total market for plant-based foods could represent up to 7.7% of the global protein market by 2030. At that time, the market could be worth more than US$162 000 million (137 000 million euros), as compared to US$29.4 billion (25 billion euros) recorded in 2020.

Although seafood analogues account for only 1% percent compared with 60% for beef, poultry and pork analogues, GFI expects that this percentage will increase. The reasons for the growing popularity of seafood analogues are not only health concerns, allergies, religious dietary rules, and food safety (free from mercury and microplastics contamination), but also the desire to support foods that are seen as sustainable without damaging the environment and the people who work in the industry.

Popular seafood analogue brands in the US and Europe include Nestlé, Tyson, General Mills, New Wave Foods, Good Catch, Ocean Hugger Foods, BeLeaf, Sophie’s Kitchen, Quorn, Seafood Co, Vegan Zeastar, Modern Plant-based Foods, Impossible Foods, Beyond Meat, Blue Nalu, etc, with the products offered being equally diverse from ‘shrimp’ to ‘fish’ and even ‘caviar’. US tuna giant Bumble Bee Foods does not produce its own seafood analogues, but it partners with Gathered Foods Corp, the parent company of Good Catch.

In Asia, the leading companies which are investing in the technology are Thai Union, Vietnamese fish producer Vinh Hoan, New Singularity (Hong Kong), HERO Protein (Shanghai), and OmniFoods (Hong Kong). Of interest to note is that Vinh Hoan recently invested in two companies which produce cell cultured seafood analogues: Shiok Meats (Singapore) which is the first cell-based seafood company in SE Asia; and also Hong Kong -based Avant Meats. Shiok Meats is working to bring its cell-cultured crustaceans to launch in Singapore and the Asia market latest by 2023. Avant and Shiok, like other companies which produce plant-based and cell-based seafoods, promote them as sustainable, cruelty-free, non-GMO, and free from heavy metals and pesticides. Plant-based seafood additionally will appeal to vegetarians and vegans, or people who are allergic to fish or shellfish, or want to reduce their consumption of animal products.

The ingredients that make up plant-based seafood include mycoproteins (mushroom), pea protein, konjac, wheat protein, soy protein, hydrocolloids, seaweed, or a mixture of different plant proteins. For example, Good Catch’s products are made from a proprietary six-legume blend of protein isolate, soy protein concentrate and isolate, high-protein chickpea flour, fava bean protein, lentil protein, and navy bean powder, which provides texture and protein in their plant-based seafood products. The aim of using these ingredients is to produce a firm gel that can be used to mimic the structure of shrimp, etc.

The common techniques of structuring plant-based proteins are hydrospinning, electrospinning, extrusion, and 3D printing. In cell-based culture, small samples of cells are taken from fish, placed in a nourishing environment, and allowed to grow.
Insight into markets and industry in Asia Pacific

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**IMPLEMENTATION OF THE CODE OF CONDUCT FOR RESPONSIBLE FISHERIES**


Fishing and aquaculture provide a vital source of food, employment, trade and economic well-being for people throughout the world, for present and future generations, and should therefore be conducted in a responsible manner. The Code of Conduct for Responsible Fisheries (the Code) sets out principles and international standards for responsible practices supporting the sustainable exploitation and production of living aquatic resources, with due consideration for the conservation of ecosystems and biodiversity, and recognising the nutritional, economic, social, environmental and cultural importance of fisheries. Twenty-five years after its adoption, the Code remains as relevant today as it was in 1995.

This booklet offers a glimpse into the objectives of the Code and the framework of instruments and guidelines that have, over the last 25 years, been built on the Code and in support of the implementation of its wide-ranging provisions. It also provides insights into some trends that can be observed through reporting by FAO Members on its implementation.

*The booklet can be downloaded through: www.fao.org.*

**HARNESSING THE DIVERSITY OF SMALL-SCALE ACTORS IS KEY TO THE FUTURE OF AQUATIC FOOD SYSTEMS**

*Short, R.E., Gelcich, S., Little, D.C. et al. Harnessing the diversity of small-scale actors is key to the future of aquatic food systems. Nat Food 2, 733–741 (2021).*

Small-scale fisheries and aquaculture (SSFA) provide livelihoods for over 100 million people and sustenance for ~1 billion people, particularly in the Global South. Aquatic foods are distributed through diverse supply chains, with the potential to be highly adaptable to stresses and shocks, but face a growing range of threats and adaptive challenges. Contemporary governance assumes homogeneity in SSFA despite the diverse nature of this sector. Here we use SSFA actor profiles to capture the key dimensions and dynamism of SSFA diversity, reviewing contemporary threats and exploring opportunities for the SSFA sector. The heuristic framework can inform adaptive governance actions supporting the diversity and vital roles of SSFA in food systems, and in the health and livelihoods of nutritionally vulnerable people—supporting their viability through appropriate policies whilst fostering equitable and sustainable food systems.

*This study can be downloaded at: https://doi.org/10.1038/s43016-021-00363-0.*

**INFORMATION AND COMMUNICATION TECHNOLOGIES FOR SMALL-SCALE FISHERIES (ICT4SSF)**


The aim of this report is to present evidence towards how Information and Communication Technologies for Small-scale Fisheries (ICT4SSF) might enable and support the implementation of the FAO’s Voluntary Guidelines for Securing Sustainable Small-Scale Fisheries in the Context of Food Security and Poverty Eradication (SSF Guidelines). We present case studies of ICT4SSF initiatives in different use areas to identify key themes and reflect on successes and failures.

There are very few baselines against which to compare fisher wellbeing and access before and after ICT initiatives, and this gap is an important finding in this report. Thus far, success has only been assessed qualitatively and relatively, in terms of uptake, sustainability and local legitimacy. Still, some ICT4SSF initiatives presented in this document are closely aligned with the Principles for Digital Development and the objectives of the SSF Guidelines. These initiatives highlighted that when ICTs are locally led or developed, or co-designed with end users and marginalised groups, or strengthened already existing networks and technologies, the potential for positive impact is much higher. However, there is much less evidence of proactive confrontation of inequality through data ownership. Further, there are very few examples of developing mechanisms for fishers and fish workers to hold, access or own their data, or legal mechanisms to recognise their ownership, or protect them against misuse or manipulation.

*The handbook can be downloaded at: https://doi.org/10.4060/cb2030en.*
THE WESTERN AND CENTRAL PACIFIC TUNA FISHERY: 2020 OVERVIEW AND STATUS OF STOCKS

Published by The Pacific Community (SPC), 2021.

The tuna fisheries assessment report (commonly referred to as the “TFAR”) provides current information on the tuna fisheries of the western and central Pacific Ocean and the fish stocks (mainly tuna) that are impacted by them. The information provided in this report is summary in nature, but a list of references (mostly accessible via the internet) is included for those seeking further details. This report focuses on the primary tuna stocks targeted by the main Western and Central Pacific Ocean industrial fisheries - skipjack tuna (Katsuwonus pelamis), yellowfin tuna (Thunnus albacares), bigeye tuna (T. obesus) and South Pacific albacore tuna (T. alalunga).

The report is divided into three parts: the first section provides an overview of the fishery, with emphasis on developments over the past few years; the second summarises the most recent information on the status of the stocks; and the third summarises information concerning the interaction between the tuna fisheries, other associated and dependent species and their environment.

The data used in compiling the report are those which were available to the Oceanic Fisheries Programme (OFP) at the time of publication, and are subject to change as improvements continue to be made to recent and historical catch statistics from the region. The fisheries statistics presented will usually be complete to the end of the year prior to publication. However, some minor revisions to statistics may be made for recent years from time to time. The stock assessment information presented is the most recent available at the time of publication.

This report can be downloaded from the website of The Pacific Community: https://www.spc.int.

EDUCATE, CONNECT, ENGAGE
2022

MARCH
13 - 15
Seafood Expo North America
Boston, USA
https://www.seafoodexpo.com/north-america/

APRIL
26 - 28
Seafood Expo Global
Barcelona, Spain
https://www.seafoodexpo.com/global/

MAY
3 - 5
Aquaculture UK
Aviemore, Scotland
https://aquacultureuk.com/

24 - 28
Thaifex - Virtual Trade Show
Bangkok, Thailand
https://thaifex-anuga.com/en/

24 - 27
World Aquaculture 2021
Merida, Mexico
https://www.was.org/meeting/code/WA2021

JUNE
1 - 3
POLFISH
Gdansk, Poland
http://polfishfair.pl/

8 - 10
Infofish World Shrimp Trade Conference and Exhibition (Virtual)
www.shrimp.infofish.org

21 - 23
Seafood Expo Russia
Saint-Petersburg, Russia
https://seafoodexporussia.com/en/

24 - 26
16th Shanghai International Fisheries and Seafood Exhibition
Shanghai, China
https://www.worldseafoodshanghai.com/en/

AUGUST
23 - 26
11th Symposium on Diseases in Asian Aquaculture (DAA11)
Sarawak, Malaysia
https://www.daa11.org/

SEPTEMBER
14 - 16
Seafood Expo Asia
Singapore
https://www.seafoodexpo.com/asia/

26 - 27
13th Seafood Expo & Seafood Processing Expo 2022
Dubai, UAE
https://www.dubaiseafoodexpo.com/

OCTOBER
11 - 13
17th INFOFISH World Tuna Trade Conference & Exhibition
Bangkok, Thailand
www.tuna.infofish.org

26 - 28
China Fisheries & Seafood Expo
Qingdao, China
https://chinaseafoodexpo.com/

NOVEMBER
29 - Dec 2
World Aquaculture Singapore 2022
Singapore
https://www.was.org/Events/Calendar#.YhwO9t8RWIE
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17th INFOFISH WORLD TUNA TRADE CONFERENCE & EXHIBITION

11–13 October 2022
Bangkok, Thailand