

COMMENTARY

The eDNA Society International Meeting 2023, “moving from knowledge into practice”

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Abstract

With the aim to gather and synthesize knowledge regarding environmental DNA analysis and its applications, The eDNA Society International Meeting 2023 was held in Otsu, Shiga, Japan, from May 17th to 19th with more than 252 participants from 19 countries. During the three core days, there were three plenary sessions with nine leading researchers in the field as invited speakers, as well as general oral sessions, a poster session, workshops presented by the society's corporate companies, and opening and closing ceremonies. The meeting had been postponed multiple times due to the COVID-19 pandemic but was finally held in-person, with options for online attendance, in front of Lake Biwa. This is a memorial site where the first field test for eDNA analysis in Japan was conducted. Here, we report the record of the meeting by sharing the highlights of the three core days. The proposed meeting theme, “Moving from Knowledge into Practice,” was well achieved during the meeting with energetic participants and enthusiastic discussion, which was stimulated by interesting presentations and lectures spanning from basic technical developments to practical applications.

KEYWORDS

knowledge into practice, social implementation, The eDNA Society

1 | INTRODUCTION

The eDNA Society was founded in 2018 in Japan with the aim to foster and develop eDNA science as a discipline that contributes to human well-being, such as the sustainable use of ecosystems and environmental conservation. The society has 312 individual members and 31 corporate company members as of July 2023, and it is the only academic society dedicated solely to the advancement of eDNA science and its applications for society in Japan. After the first meeting that was held in 2018 in Tokyo, the society has held the meeting annually to provide the society members with the occasion to exchange ideas and knowledge, thereby contributing

to the sharing of the benefits generated through new technology. Interestingly, approximately half of the society members are from private sectors that are currently providing eDNA analysis services, using the technology for their business, or have an interest in its future use. The society has provided essential contributions to the eDNA community by leading the standardization of survey/analytical procedures (Minamoto et al., 2020) and providing technical seminars (Araki et al., 2022) at the beginning implementation stages of new technology even during the COVID-19 pandemic. Implementations have been on going in governmental sectors of Japan, for example, the Ministry of the Environment has published a manual for eDNA analysis (https://www.biodic.go.jp/edna/reports/mifish_tebiki3.pdf)

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and the Ministry of Land, Infrastructure, Transport, and Tourism has been discussing how to use the technology as an alternative/complementary tool for their conventional national biodiversity census (Kitagawa et al., 2020).

Given the recent inclusion of eDNA science in Japanese companies and governmental groups as well as the academic sectors, The eDNA Society has been motivated to facilitate technique standardization and turn it into an effective and reliable tool for practical use. It was expected that providing an opportunity for individuals to gather in-person, not only from Japan but also from other countries, to mutually share recent advances in eDNA analysis and its related fields, would contribute toward the domestic and international demand for the standardization of analysis procedures and applied usage to facilitate the conservation of global biodiversity. After multiple postponements of the international meeting due to the COVID-19 pandemic, it was decided to hold it in May 2023 after the Japanese government decision to relax the immigration rules in fall of 2022. For an international meeting, the notice was late with the first advertisement in Jan 2023, but there were 252 participants from 19 countries including nine invited speakers to three plenary sessions and Dr. Mehrdad Hajibabaei, University of Guelph, Canada, to give a lecture during the closing ceremony. General oral and poster sessions were provided for participants to share presentations. Additionally, two corporate workshops were hosted by sponsor companies. The main meeting theme, "Moving from Knowledge into Practice," reflected our expectations for the meeting to be a memorable turning point in the history of eDNA science toward the empowerment of new technology to be scientifically practical and legal. The meeting successfully completed a three-day timetable with enthusiasm from all involved (Figure 1) followed by 2 days

of Japanese cultural excursions. The sections that follow detail the highlights of the meeting.

2 | HIGHLIGHTS FROM THE MEETING

2.1 | Opening ceremony

The president of The eDNA Society, Dr. Toshifumi Minamoto, opened the conference by stating that it was a pleasure to have an in-person conference on the shore of Lake Biwa, the birthplace of eDNA research in Japan, to further develop eDNA research, which has progressed at an amazing pace in the 15 years since the publication of the pioneering study in 2008 (Ficetola et al., 2008). He reaffirmed the importance of the conference theme, "Moving from Knowledge into Practice," and stressed the need for international collaboration to achieve this, which includes the standardization of methods. He also emphasized that researchers should not forget the excitement of science.

Following the opening remarks, Dr. Michio Kondoh, the first president of The eDNA Society, gave a presentation entitled, "ANEMONE: Japan's eDNA-based biodiversity monitoring network." ANEMONE is a nationwide biodiversity monitoring network that utilizes eDNA metabarcoding in Japan. Originally started by researchers, eDNA metabarcoding biodiversity monitoring has been joined by citizen scientists, with more than 1000 sites surveyed and over 5000 surveys conducted, and the data is publicly available in the ANEMONE database. While conducting a large-scale survey, it is important that anyone can participate, and ANEMONE uses a standardized protocol based on the manual developed by The eDNA



FIGURE 1 (a) Group photo of the participants. (b) The meeting venue, Piazza Omi, Otsu, Japan. (c) Scenery from the venue, Lake Biwa.

Society. In this presentation, it was noted that the success of this standardization enabled the establishment of a large-scale monitoring network. The ANEMONE consortium, which was established by various sectors, was introduced and the pathway that the development of eDNA research can take to realize a nature-positive society was described.

2.2 | Plenary session 1

The first symposium (plenary session 1) was titled, “From innovation to practice: Utilizing eDNA for evidence-based management,” and took place on May 17th. The objective was to provide a platform for participants to learn and discuss the practical applications of eDNA-based data for biodiversity conservation and fishery resource management. The session featured four speakers and covered various topics related to the optimization of eDNA analysis and enhancing its efficiency for future monitoring programs. Dr. Elizabeth Andruskiewicz Allan from The eDNA Collaborative, USA, delivered the first talk titled, “The evolution of eDNA sampling: From bottles to robots.” Her presentation highlighted the development of advanced robotic samplers for eDNA monitoring and evolution of sampling methodologies. The inclusion of autonomous samplers sparked the audience's interest regarding the future adoption of cutting-edge tools for monitoring programs. Dr. Adam Sepulveda presented, “Transitioning eDNA biomonitoring from research to operational use for invasive species early detection,” remotely from the United States Geological Survey, USA. He introduced an ongoing monitoring project in the USA, known as the Rapid eDNA Assessment and Deployment Initiative & Network (READI-Net), which also incorporated automated eDNA samplers. This integration aimed to ensure sustainable, long-term eDNA biomonitoring with frequent sampling and the transition from manual labor to automated procedures and promoted standardization. Dr. Alison Watts from the University of New Hampshire, USA, delivered a talk titled, “Establishing long term monitoring programs to support actionable science and conservation.” She shared her experience while implementing a coastal monitoring program in the USA that integrated eDNA sampling. The addition of new technology facilitated the understanding of long-term trends in biodiversity, target species, and food webs. Dr. Watts emphasized the importance of balancing standardization with the use of the best available methods and designing monitoring programs to directly address the relevant management questions. The final speaker, Dr. Ryan Kelly from the University of Washington, USA, presented, “Moving eDNA methods from knowledge into action.” He discussed strategies to empower eDNA data as a core component for evidence-based environmental management. Dr. Kelly emphasized the need to make eDNA-based tools practical, useful, and legally compliant, thus highlighting their social and political effectiveness. The symposium concluded with a panel discussion that encouraged the exchange of ideas among the speakers and audience. This day one symposium was co-organized by the Center for Biodiversity Science at Ryukoku University, Japan.

2.3 | Plenary session 2

The next plenary session (plenary session 2), “Understanding biodiversity hotspots using eDNA,” was held on May 18th. This session was organized by Dr. Hitoshi Araki from Hokkaido University and Dr. Tadashi Kajita from the University of Ryukyus, Japan, and three external plenary talk speakers were invited. The aim of the session was to share eDNA-based research knowledge in a variety of biodiversity hotspots. The research subject areas included studies on mangrove forests, coral reefs, open oceans, and freshwater systems. After the introduction of the session, Dr. Hitoshi Araki provided a talk titled, “Monitoring aquatic ecosystems in Hokkaido as a salmonid diversity hotspot in Japan.” He illustrated that eDNA metabarcoding was the most efficient tool for biodiversity monitoring in the second-largest main island of Japan (83,450 km²), for a wide variety of wild organisms including many kinds of salmonid fish in Hokkaido, Japan. The target species included the endangered Sakhalin taimen (*Parahucho perryi*) and Southern Asian Dolly Varden (*Salvelinus curilus*), both of which have limited species distribution in Hokkaido. He showed results from eDNA studies on their potential competitors and invasive predators such as the rainbow trout (*Oncorhynchus mykiss*) and American mink (*Neovison vison*). By monitoring them together using eDNA metabarcoding approaches, he illuminated the potential associations among these organisms in the wild and the risk that the invasive species has on the endangered species. The next presentation was by Dr. Christoph Deeg from the University of British Columbia, Canada titled, “Environmental DNA surveys of Pacific salmon ecosystems from natal rivers to the open ocean.” He reported the international collaboration survey based on the International Year of the Salmon (<https://yearofthesalmon.org/>) in addition to their own eDNA surveys. This international survey was conducted by Canadian, American, and Russian researchers in the North Pacific regions. This large-scale survey enabled them to understand not only the spatial distribution of multiple salmonid species in the Pacific Ocean but also their complex interactions with other organisms including their predators and prey. Although the results were still preliminary, it was promising that international collaborative surveys on biodiversity monitoring at the global level provide a profound understanding of the mechanisms behind the maintenance of biodiversity hotspots. The third presentation titled, “Using eDNA to understand the diversity of and anthropogenic impacts on coral reefs in southern Japan,” was provided by Dr. James Davis Reimer from the University of Ryukyus, Japan. He presented a study on the coral reefs of southern Japan, focusing on eDNA research of multiple potential bioindicators that reflect the ongoing coral reef degradation. He elucidated the need for the generation of baseline data to make robust comparisons between locations and across time, and thus the need for additional eDNA surveys that allow for appropriate actions of timeous coral reef conservation. The fourth presentation, “Applications of eDNA metabarcoding for baseline biodiversity surveys in southern African marine and freshwater ecosystems,” was by Dr. Sophie von der Heyden from Stellenbosch University, South Africa. She introduced her

eDNA studies on fish species along the South African coastline and Okavango Delta in Botswana. Her studies clearly suggest that biogeographic patterns characterize the coastal biodiversity in fish and that eDNA is a powerful tool to discover this biodiversity, especially in remote areas such as the Okavango. However, she also pointed out the need for the development of the eDNA metabarcoding technique, its reference database, and a better relationship between the local stakeholders and eDNA researchers for the self-sustainable monitoring of biodiversity in these areas (von der Heyden, 2022). The final presenter was Dr. Tadashi Kajita, and his presentation was titled, "Understanding global mangrove biodiversity by eDNA metabarcoding." Although the time for this presentation was limited, he definitively highlighted that international collaboration is absolutely necessary to understand the current biodiversity in hotspots such as mangrove forests and that the reference database needs to be further developed to facilitate the efficient worldwide monitoring of mangrove biodiversity. The symposium concluded that eDNA-based biodiversity monitoring often shares common interests and issues and that communication among researchers of different biodiversity hotspots is essential for the further improvement of eDNA techniques and enhancement of biodiversity hotspot management.

2.4 | Plenary session 3

The third symposium (plenary session 3) titled, "Environmental DNA moving from knowledge into practice," took place on May 19th. The session was organized by Dr. Hideyuki Doi of Kyoto University, Japan, and aimed to discuss the current state of eDNA research, its potential applications, and the challenges of implementing eDNA surveys for ecological monitoring. Its objective was to provide a platform for participants to learn and discuss the practical application of eDNA-based data for biodiversity conservation and fishery resource management. As the introduction of the session, Dr. Doi provided an overview of the importance of eDNA methods in biological monitoring and the need to develop survey methods and indicators to understand the ecosystem status. He highlighted the large area and high-frequency survey capabilities of eDNA methods and their potential contributions to the development of indicators. He emphasized the need to discuss limitations and the challenges associated with the implementation of eDNA surveys and proposed measures to address them. Dr. Florian Leese, University of Duisburg-Essen, Germany, then presented his research on the advancement of biodiversity monitoring using eDNA. He discussed the progress of method innovation and successful implementation of eDNA surveys in different ecosystems. He addressed the challenges of scaling up eDNA surveys to a national scale and emphasized the importance of standardization and data sharing for efficient biodiversity monitoring. Dr. Kristy Deiner from ETH Zurich, Switzerland, discussed the potential to coordinate a global biodiversity monitoring system using eDNA and blockchain technology. She highlighted the benefits of integrating these technologies to improve data reliability, traceability, and accessibility. She also emphasized the importance of collaboration among researchers,

stakeholders, and policymakers to establish a robust and globally coordinated eDNA monitoring network. She addressed the ethical and legal considerations related to data sharing and privacy in the context of blockchain implementation. Lastly, Dr. Keigo Nakamura, from the Riverfront Research Center, Japan, provided insights into the social implementation of eDNA and the barriers faced in Japan. He discussed the engagement of various stakeholders, including policymakers, local communities, and industries in eDNA research and monitoring projects. He emphasized the need for effective communication strategies to raise awareness, address public concerns, and promote the adoption of eDNA methods for ecological monitoring. He also discussed the regulatory and legal challenges that need to be overcome for the broader use of eDNA surveys in Japan. This session concluded the challenges of eDNA survey implementation, including protocol standardization, data analysis, and interpretation, and summarized the need for capacity building and collaboration across sectors in eDNA research and society. Participants recognized the importance of continued dialogue, knowledge sharing, and interdisciplinary collaboration to advance the practical implementation of eDNA methods for biodiversity monitoring.

2.5 | Oral and poster presentations

Participants presented 39 oral presentations and 80 posters during the meeting. The best presentation prizes for poster presentations were determined, and the winners were honored at the closing ceremony. The winners were.

2.5.1 | Best poster award

"Zooplankton sedimentary DNA as an effective tool for tracking past population dynamics,"

Narumi Tsugeki (Faculty of Law, Matsuyama University), Kai Nakane (Center for Marine Environmental Studies, Ehime University), Hideyuki Doi (Graduate School of Informatics, Kyoto University), Kazuaki Tadokoro (Shiogama Field Station, Fisheries Resource Institute), Michinobu Kuwae (Center for Marine Environmental Studies, Ehime University).

2.5.2 | Best student poster award

"Environmental mRNA-seq of *Xenopus laevis* and *Gasterosteus aculeatus*,"

Fei Xia, Jiwei Yang, Yuanyu Wang (Graduate School of Frontier Sciences, The University of Tokyo), Yihan Ma (Faculty of Environment and Information Studies, Keio University), Susumu Yoshizawa (Graduate School of Frontier Sciences, The University of Tokyo), Hiroki Kuroda (Graduate School of Media and Governance, Keio University), Asano Ishikawa, Wataru Iwasaki (Graduate School of Frontier Sciences, The University of Tokyo).

2.6 | Closing keynote

Dr. Mehrdad Hajibabaei from the University of Guelph, Canada, delivered the closing keynote. He emphasized the fundamental connection between biodiversity and human well-being and stressed the urgent need for effective tools and approaches in biodiversity analysis, particularly in light of the ongoing “biodiversity crisis.” Acknowledging the significant contributions of eDNA methods in biodiversity analysis, Dr. Hajibabaei remarked on the current limited use of eDNA tools in environmental assessment and monitoring programs. One highlighted challenge was the difficulty in verifying and validating the generated data due to the absence of standardized measurement protocols in broader settings. To overcome these barriers, Dr. Hajibabaei called for the standardization of eDNA protocols, enabling the widespread use of eDNA and unlocking its full potential to understand and mitigate the biodiversity crisis. This message represents one of the most important achievements of this meeting, demonstrating the collective efforts in developing eDNA methods as a standardized tool for biodiversity monitoring. The eDNA Society, in collaboration with global allies including the participants of this meeting, will continue to advance the eDNA methods and deepen our understanding of the nature of biodiversity, toward the goal of promoting global biodiversity conservation and ecosystem preservation.

AUTHOR CONTRIBUTIONS

HY led the work. All authors contributed to writing and editing.

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CONFLICT OF INTEREST STATEMENT

The authors of this meeting report are not necessarily part of The eDNA Society.

DATA AVAILABILITY STATEMENT

Data sharing is not applicable to this article as no new data were created or analyzed. Resources: The eDNA Society website: <https://ednasociety.org/>.

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