

2023 Report of the Advisory Panel on Marine Non-indigenous Species

Following a very successful in-person meeting in Busan, Korea at PICES-2022 the Advisory Panel on Marine Non-indigenous Species (AP-NIS) met both virtually and in-person as part of PICES-2023 business activities. This represented the seventh meeting of this PICES expert group and although there were some challenges related to travel as we emerge from the global COVID-19 pandemic most members were able to travel to Seattle, USA and participate in-person for most agenda items. Dr. Therriault (Canada), the co-chair of this PICES expert group, circulated an initial draft agenda to members in August 2023 and based on comments and feedback the draft agenda was revised. Concurrently, in late August, at the request of the PICES Secretariat, a virtual pre-meeting was added to the draft Agenda for mid-September 2023 and the draft agenda was finalized (*Endnote 2*). The intent of the virtual meeting was to cover any issues requiring PICES Science Board or Governing Council approval while the in-person meeting was focused on information exchange and in-depth discussion of AP-NIS business. Thus, the AP-NIS business meetings were convened virtually on Wednesday September 13/Thursday September 14 and in-person on Sunday October 22, 2023 starting at 9:00 at the Westin Hotel, Seattle, USA. The details and outcomes of these meetings are provided below in sequential order for consistency.



AP-NIS Members and Participants in Seattle, Washington, USA.

AGENDA ITEMS 1-7 (VIRTUAL MEETING)

Dr. Therriault called the virtual meeting to order on September 13, 2023 at 5:00 PM (Pacific Daylight Time) and acknowledged that some AP-NIS members were unable to attend due to scheduling challenges. Following introductions, members adopted the draft agenda (*Endnote 2*). Although two new members were appointed to AP-NIS from the USA just prior to our business meeting in Busan, neither were able to attend. Thus, both Drs. Joseph Krieger and Carolyn Tepolt provided a more in-depth introduction to themselves, their expertise, and research activities (Agenda Item 2). Both bring molecular backgrounds that will enhance AP-NIS' goal of improved understanding and application of these approaches for early detection of marine non-indigenous species around the Pacific. Dr. Therriault then led a quick review of the Terms of Reference for this expert group and the preliminary annual report for MEQ (Agenda Item 3). It was decided that no changes were necessary for the Terms of Reference but it was noted that additional members from Japan and the USA would

be identified at the in-person meeting in Seattle. Thus, it was agreed that Dr. Therriault would make a request via MEQ and Science Board that the Japanese Governing Council delegates consider adding Prof. Keiji Iwasaki, Nara University while the USA Governing Council delegates considering adding Dr. John Darling, US Environmental Protection Agency. Prof. Iwasaki has expertise in benthic invaders while Dr. Darling has expertise in applying molecular tools to better understand invasion dynamics. Both would be valuable members should they be appointed. The AP then discussed the primary objectives of this pre-PICES virtual business meeting which was to review and discuss items requiring Science Board approval (Agenda Item 4). The specific requests related to travel support for AP-NIS participation in meetings, workshops, conferences, etc.; changes in ToR, membership, etc.; possible capacity development opportunities; new Expert Groups; and other items requiring Science Board approval were each discussed in order. Other than the addition of new members from Japan and USA already noted, AP-NIS did not identify any other needs requiring MEQ or Science Board approval at PICES-2023. Dr. Therriault then noted that AP-NIS has had several very successful topic sessions and workshops at PICES Annual Meetings and this was a major activity of the Advisory Panel (Agenda Item 5). This includes S6 on “The complex reality of managing Non-indigenous Species (NIS) in the North Pacific “ convened at PICES-2023 (Thurs Oct 26) followed by a special one-day technical meeting on European Green Crab research along the west coast of North America to identify research needs to improve management (Fri Oct 27). Both were very well attended and S6 was able to attract four invited speakers who covered their own expenses to attend the meeting! Members agreed that hosting such events have immense value beyond contributing to its Terms of Reference and that a session should be proposed by AP-NIS for consideration at PICES-2024 (Location TBC). Recognizing this desire Drs. Therriault, Zhan, and Krieger submitted a Topic Session proposal entitled “East Meets West and West Meets East: Past, Current and Future Implications of Non-indigenous Species (NIS) in the North Pacific” (*Endnote 3* and Agenda Item 16) via the online portal before the September 22, 2023 deadline. In addition, Dr. Therriault presented this proposal at the MEQ virtual business meeting and it was subsequently supported by the committee. The final determination will be made by Science Board and success or not will be communicated to AP-NIS once a decision is made. Dr. Therriault then reviewed the remainder of the Agenda with AP-NIS members (Agenda Item 6) and with no other business (Agenda Item 7) Dr. Therriault closed the virtual component of the business meeting and wished members safe travel to Seattle for the remainder of this year’s business meeting.

AGENDA ITEMS 8-9 (IN-PERSON MEETING)

The in-person component of the business meeting got started on Sunday October 22, 2023 at 9:15 AM at the Westin Hotel following some co-chair inflicted logistical confusion around room assignments. Following apologies for the delay, Dr. Therriault led a round of introductions and members/observers adopted the agenda indicating there were no further changes since the virtual meeting (Agenda Item 8). It is no surprise that PICES meeting formats and logistics have been a topic of interest as COVID-19 pandemic restrictions ease but geopolitical and financial hurdles remain. At PICES-2022 in Busan AP-NIS reiterated the benefits and the need for in-person meetings to advance AP-NIS business but many members were confused when we were asked to hold a “mandatory” virtual pre-PICES business meeting. Thus, AP-NIS had considerable discussion about how AP-NIS should function and the strengths and weaknesses of various approaches (Agenda Item 9). Overall AP-NIS unanimously supports annual in-person meetings of this PICES expert group. All member nations present recognize the challenges around in-person meetings such as financial implications, carbon emissions, etc. but strongly believe that in-person meetings are essential for AP-NIS to make progress on its Terms of Reference and that hybrid or virtual options should only be used to advance specific topics intersessionally where in-person meetings would be prohibitive (having a 1-day meeting of AP-NIS intersessionally would be hard to support so having it associated with the Annual Meeting was deemed important). For members who are not native English speakers they expressed concern that virtual meetings make it hard to engage and fully participate in discussions and decisions. In-person meetings are much more accessible, especially given the very large differences in time zones among member institutions, which directly translates to increased engagement and participation. Further, members each stated that so long as in-person meetings are part of the PICES schedule their respective agencies would make every effort to allow them to travel to participate. It was noted that should meeting rooms be fully equipped and managed by technical specialists that a hybrid option may allow more Early Career Ocean Professionals (ECOPs) to participate as they are less likely to be fully

supported to attend in-person. The involvement of ECOPs was also discussed last year and despite efforts to engage them in AP-NIS business this did not translate to a notable increase in their participation in Seattle. AP-NIS looks forward to suggestions from AP-ECOP in how this may change in the future. Thus, given these discussions Dr. Therriault will ask MEQ and Science Board for a 1-day business meeting at PICES-2024.

AGENDA ITEM 10 (IN-PERSON MEETING)

PICES has a long history of collaborations with NOWPAP, especially on topics related to MEQ including non-indigenous species (NIS) and harmful algal blooms (HABs). New MEQ member Dr. Yoshida (Japan) who historically attended many PICES meetings as the NOWPAP-CEARAC liaison confirmed that due to the ongoing conflict between Russia and Ukraine NOWPAP activities remain largely stalled (Agenda Item 10). There remains a strong interest and commitment to advance topics of mutual interest between NOWPAP and PICES such as eDNA tools for detecting NIS when NOWPAP activities resume.

AGENDA ITEM 11 (IN-PERSON MEETING)

PICES also has a long history of collaborations with ICES on a broad array of topics including non-indigenous species. Within ICES there are two expert groups dealing with different aspects of NIS including the Working Group on Introductions and Transfers of Marine Organisms (WGITMO) and the Working Group on Ballast and Other Shipping Vectors (WGBSOV). Both have Terms of Reference dealing with eDNA and/or application of molecular tools. These efforts compliment the multiple topic sessions convened at PICES Annual Meetings on eDNA applications, including detecting NIS, by AP-NIS in addition to several discussions during annual business meetings. Thus, Dr. Therriault invited Dr. John Darling (ICES, USA) to update AP-NIS on ICES activities, especially a new ICES Viewpoint being developed (Agenda Item 11). Dr. Darling provided an overview of an effort underway within ICES to produce a Viewpoint on standards for the application and interpretation of eDNA results for non-native species. A workshop held in conjunction with the 11th Marine Bioinvasions Conference in Baltimore in May 2023 leveraged international participants working on interpreting eDNA results for NIS management, including but not limited to biosecurity. There was considerable discussion among AP-NIS members about the rapidly evolving landscape of applying molecular tools for NIS early detection including both qPCR and metagenomic/metabarcoding methods where several domestic and international groups/organizations are developing decision trees for molecular detections (see in part next agenda item) but no international guidance or standards yet exist. Thus, ICES (possibly in collaboration with PICES) could develop guidance for such uses via the suggested Viewpoint. Ultimately the goal is to ensure regulators globally have the ability to trust molecular-based detections of NIS as most eDNA labs are not forensically certified like those used for disease detection where clear standards exist. By developing guidance for standards it will ensure any comparisons are meaningful, including applications beyond NIS detection such as biodiversity or fisheries applications. This compliments ongoing discussions within AP-NIS on eDNA sampling guidance developed both by the Japanese eDNA Society and Fisheries and Oceans Canada and planned activities with NOWPAP on training in these collection methods as capacity building workshops (currently paused). Members also discussed the need for any of this work to be highly applicable across geographic areas and that an interlab comparison project may be helpful to validate results, identify acceptable tolerances, reproducibility, accuracy, etc. Thus, AP-NIS agreed that the ICES Viewpoint was a valuable scientific contribution with applications beyond just the ICES community and agreed to review the document when ready and contribute to the development of the more in-depth supporting document with a goal to ensure more recent advancements in Asia are captured. In addition, Dr. Therriault agreed to talk to MEQ and the PICES Secretariat to explore options about development of a similar position document or some level of endorsement for the ICES Viewpoint.

AGENDA ITEM 12 (IN-PERSON MEETING)

In addition to the specific collaboration with ICES related to eDNA above, AP-NIS members are aware of several projects developing or using eDNA tools such as the eDNA manual that has been developed by the eDNA Society of Japan and the Fisheries and Oceans Canada Canadian Science Advisory Secretariat Research Documents on eDNA applications. However, how best to implement these remains a challenge. Thus, AP-NIS

discussed the role it could play in reviewing these existing documents to identify a standardized approach that could be applied among PICES member countries (Agenda Item 12). The intent would be to develop this as plain language guidance to ensure broad uptake by those applying these tools (avoiding the technical jargon that can create confusion among non-experts). AP-NIS members agreed to identify such documents within their countries and these should be shared on the AP-NIS SharePoint site in development (see below).

AGENDA ITEMS 13-17 (IN-PERSON MEETING)

Information sharing is a central theme within AP-NIS (Agenda Items 13-17). ToR 1 states the AP will continue to share information on marine non-indigenous species (NIS) in the North Pacific via an updated NIS database. At the first AP-NIS business meeting at PICES-2017 in Vladivostok, discussions started on the most appropriate database to exchange such information and at PICES-2018 in Yokohama, members agreed that the ICES-sponsored database AquaNIS would be preferred, in part due to the long history of collaboration on marine science issues between PICES and ICES, including on NIS. However, collecting such information has been challenging, in part due to COVID-19 restrictions and membership changes. At this year's meeting members agreed to trial a small batch of species from their respective countries to ensure AquaNIS is fit-for-purpose. There was some discussion about the choice of database but it was recognized there is not a Pacific-centric NIS database in existence but that the AquaNIS database can have Pacific Ocean ecoregions added or redefined as needed (a detail previously confirmed with the database managers). Thus, once each country has entered some "trial" species it will be possible to better understand if this is the best database option for AP-NIS. Further, at PICES-2022 AP-NIS identified the need to share information beyond NIS occurrences and discussed possible methods for doing so. Dr. Therriault had discussions with the PICES Secretariat about hosting an AP-NIS website page that will allow members to post and exchange things like primary publications or links to key products (technical reports, manuals, etc.). The Secretariat agreed it was possible for AP-NIS to have a SharePoint site via the PICES website and that this would be created shortly after the PICES-2023 Annual Meeting. Further, a draft reporting template was developed at PICES-2022 and was trialed by Canada at PICES-2023. Generally, this worked well and other countries plan to use the reporting template at the next business meeting of the group at PICES-2024.

In general, these individual country reports allow the broad exchange of information about NIS around the Pacific, including but not limited to, new incursions, spread of existing NIS, new policies or regulations, new control efforts, etc. This year Canada reported that the high-risk crustacean invader, European Green Crab (*Carcinus maenas*), continues to spread along the west coast of North America with new incursions detected in Prince Rupert in August 2023. It was also noted that S6 at PICES-2023 was largely focused on this invader and management options and considerations to deal with it. An additional technical meeting was added to leverage expertise attending the PICES Annual Meeting in Seattle by European Green Crab experts. Additional risk assessment and research projects are ongoing and new publications will be shared with AP-NIS once the AP's SharePoint site is established. A highlight from Japan included an update to a previous publication from 2004 where the number of NIS, Intentionally Introduced and Cryptogenic species in marine, estuarine and freshwaters of Japan are documented. Not surprisingly, this number has increased over the past two decades. Korea highlighted a project whereby high-risk invaders to the country have been identified where one (*Perna viridis*) was recently detected on a vessel in a Korean port. It is too early to know if this species has become established but showcases the need for early detection of high-risk NIS. Currently there is not a dedicated monitoring network for NIS but these are encountered in general diversity monitoring programs which have detected an increasing number of NIS, especially in the south of the country, due to climate change effects that are allowing more tropical species to enter their waters including very venomous ones like the Blue-ringed Octopus (*Hapalochlaena lunulate*). Some key updates from the US included a new National early detection and rapid response (EDRR) framework for invasive species aimed at finding and eradicating initial invasive species infestations before they spread and cause harm, thereby protecting the Nation's lands and waters and the communities they support. The focus of this framework is addressing invasive species new to the United States or those that have moved large spatial distances and includes identifying high risk invasive species and invasion hotspots across the Nation to inform early detection efforts, developing molecular tools to aid early detection capabilities, expanding capacity for on-the-ground rapid response actions, and creating an online clearinghouse where managers can share current information to guide implementation. Once complete it could fundamentally

change how the US, and other nations of the world, management and control the introduction of new invasive species. Further, the National Invasive Species Council (NISC) workplan has identified priorities for Islands and International Engagement – both of high relevance for AP-NIS and a partnership that will be explored when drafting the business meeting and topic session for AP-NIS at the next PICES Annual Meeting.

AGENDA ITEM 18 (IN-PERSON MEETING)

AP-NIS has discussed the idea of some sort of joint project at almost all of its business meetings. This year, Korean delegate Dr. Choi brought forward an idea linked to a possible funding mechanism within Korea for international collaboration (Agenda Item 18). The aim of this call for proposals was to advance genomics approaches, including eDNA/eRNA, to characterize and track ecosystem responses to environmental stressors. AP-NIS discussed how such a project would build on past activities on eDNA for early detection and that PICES is well positioned to be able to bring together experts from around the Pacific to work on this important topic. Specifically, the project could involve looking at regional differences around PICES member countries in molecular indicators, characterizing how these may be responding to stressors such as invasive species, harmful algae, or other anthropogenic stressors. It could even include interlab work among research labs applying eDNA/eRNA in different PICES countries to understand variability and develop international standards (which is also aligned with the ICES work above) or could include processing of collections made around the Pacific by AP-NIS members or collaborators and processed following a universal bioinformatics pipeline in Korea. If successful, this project would span five years. However, one key requirement of the funding agency was that international participants sign a Letter of Intent which was considered potentially problematic for individual members of the AP who generally represent federal agencies and the timeline to secure permissions greatly exceed the timeline of the project proposal. After considerable discussion it was decided that Drs. Therriault and Choi would discuss the possibility of PICES signing this letter on behalf of the Advisory Panel. Subsequent discussions with the PICES Secretariat, including Special Project Coordinator, Dr. Alexander Bychkov, resulted in a Letter of Intent signed by the PICES Executive Secretary, Dr. Sonia Batton. AP-NIS members will work with Dr. Choi to develop the project proposal and if successful will help implement this project in future years.

AGENDA ITEM 19 (IN-PERSON MEETING)

There are a number of global initiatives underway of possible interest to AP-NIS (Agenda Item 19). Dr. Therriault indicated that World Ocean Assessment 3 (WOA3) is now underway and that if AP-NIS members are interested in participating in this assessment then they should go through the nomination process to be added to the Pool of Experts via their respective country's process. Also, IPBES (a UNEP program) just released their report entitled "Thematic Assessment Report on Invasive Alien Species and their Control of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services" along with a supplemental document for policy makers and the United Nations released a document entitled "Surveillance Guidelines for Alien Invasive Species in the Marine Environment".

AGENDA ITEMS 20-23 (IN-PERSON MEETING)

As the FUTURE SSC liaison with AP-NIS, Dr. Therriault provided a brief update (Agenda Item 20) highlighting alignment with the UN Decade for Ocean Science and linkages to AP-NIS as NIS are a global threat to healthy and productive marine ecosystems. Since Science Board requested information from expert groups in advance of PICES-2023 but Dr. Therriault reviewed the expert group report that included some new input from the in-person meeting and AP-NIS members agreed with its content (Agenda Item 21). Dr. Therriault attended W1 at PICES-2023 as AP-NIS co-chair to learn more about planned communication products including new Fact Sheets for PICES expert groups. Thus, under new business (Agenda Item 22) he outlined the strategy and the next steps which would be for AP-NIS members to contribute to the development of the fact sheet for AP-NIS. Finally, Dr. Therriault thanked meeting participants and concluded this in-person meeting of PICES AP-NIS (Agenda Item 23).

AP-NIS Endnote 1

AP-NIS participation list

Members

Thomas Therriault (Canada, Co-chair)
Hiroshi Kawai (Japan-virtual)
Satoshi Nagai (Japan)
Keun-Hyung Choi (Korea)
Kyoungsoon Shin (Korea)
Joseph Krieger (USA)
Carolyn Tepolt (USA)

Members unable to attend

China: Aibin Zhan (Co-chair), Lijung Wang,
Li Zheng

Korea: Jongwoo Park

Observers

Keyseok Choe (Korea)

John Darling (USA, ICES)

Alex Davis (Canada/USA, ECOP)

Seung Ho Baek (Korea)

Bonggil Hyun (Korea)

Jm-Young Seo (Korea)

AP-NIS Endnote 2

AP-NIS meeting agendas

(S6 NIS Management Topic Session, Thurs Oct 26, 2023)

(Optional European Green Crab Technical Meeting, Fri Oct 27, 2023)

Virtual Meeting Agenda

- 1) Welcome, Introductions, Opening Remarks
- 2) Introduction of new members
- 3) Review AP-NIS ToR and Discuss Progress/Achievement for Annual Reporting
- 4) Discuss and Rank Requests for Science Board
 - a. Travel support for AP-NIS participation in meetings, workshops, conferences, etc.
 - b. Changes in ToR, membership, etc.
 - c. Possible capacity development opportunities
 - d. New Expert Groups
 - e. Other items requiring Science Board approval
- 5) Discuss Topic Session and Workshop Proposals for PICES-2024 (Date/Location, TBC) – Due Sept 22, 2023 (online)
- 6) Review Draft Agenda for In-Person Meeting in Seattle
- 7) Other Business

In-Person Meeting Agenda

- 8) Welcome, Introductions, Opening Remarks
- 9) Discuss AP-NIS meetings/logistics going forward
 - a. PICES is encouraging more online meetings
 - b. ICES meetings rotate among member countries with meetings not linked to ASC
 - c. Some PICES ExGs meet annually but not at the PICES Annual Meeting
 - d. Possibility of some hybrid options?
 - e. How did PICES-2023 meetings work?
 - f. Others?
- 10) Update on PICES collaborations with NOWPAP (TBD)
 - a. Update on eDNA training workshops within NOWPAP and potential for new activities
- 11) Update on PICES collaborations with ICES (Darling)
 - a. Update on Molecular Monitoring for NIS within ICES. John Darling will provide an update on the outcomes of a workshop held in conjunction with ICMB in Baltimore (May 2023)
 - b. Discuss possible collaboration or similar position paper within PICES
- 12) AP-NIS members agreed to identify documents related to standardized methods for use of eDNA for NIS early detection/monitoring within their countries that can be discussed at PICES-2023.
 - a. Japanese eDNA Society manual
 - b. DFO's Science Advisory Report
 - c. Others
- 13) Continue to share information on marine NIS in the North Pacific via an updated database (ToR 1)
 - a. Describe progress in collecting NIS information for AquaNIS (number of records, etc.). Agreed to this action at PICES-2018 and PICES-2021.
 - b. This ToR is about collecting information on any NEW NIS invasions in PICES member countries and the spread of existing NIS in PICES member countries
- 14) Continue to exchange information on updated regulations/policy, best practices for monitoring, early detection, rapid response, and control/containment options (ToR 2)
 - a. Goal is to capture any changes to policy or regulations
 - b. Goal is to understand the types of NIS monitoring in each PICES member country (target species, locations, etc.). This is more about the "how" monitoring is being done rather than the "finding of NIS via monitoring (which is ToR 1)"
 - c. Goal is to understand if there have been any rapid responses to new detections or status of ongoing control/management efforts
 - d. This ToR is about exchanging information on lessons learned, what worked well and what didn't
- 15) Develop a better understanding of changing distributions of NIS and invasion pathways and vectors in the context of global climate change including expected changes in water temperature, salinity, oxygen, and pCO₂ (ToR 3)

- a. This is ToR is more about research and/or risk assessment. Include any new findings for species or vectors/pathways. Also, include any advice for managers or other end-users.
 - b. **Action Item** from PICES-2022: Ask PICES for website to share primary papers or technical reports.
- 16) Plan workshops/sessions/symposia related to NIS topics. (For example, a joint PICES/ICES Theme Session on “The increasing importance of biofouling for marine invasions: an ecosystem altering mechanism” was held at the 2014 ICES Annual Science Conference) (ToR 4)
- a. Continued interest/discussions with NOWPAP and ICES
 - b. Potential capacity building activities or ECOP engagement
 - c. Session/Workshop at NIS meeting/conferences
 - d. Debrief from ECOP support at ICMB in Baltimore (May 2023)
- 17) Work with other international, intergovernmental organizations (e.g., IMO, ICES, NOWPAP and WESTPAC) and/or countries to accomplish these Terms of Reference, especially those related to data/information exchange (ToR 5)
- 18) Discussion of a Special Project to be undertaken by AP-NIS (Time Permitting)
- a. Possible focus on biofouling issue in the North Pacific
 - b. Possible species or vector of common interest
- 19) Update on Global NIS Activities of Interest to AP-NIS
- a. World Ocean Assessment 3 has started with expected Chapter on NIS
 - b. Others?
- 20) Update on PICES FUTURE Program, including UN Decade for Ocean Science
- 21) Finalize info/funding requests for MEQ
- 22) Other Business
- 23) Adjourn

AP-NIS Endnote 3

Proposal for a Topic Session on

East Meets West and West Meets East: Past, Current and Future Implications of Non-indigenous Species (NIS) in the North Pacific
at PICES-2024

Proposed by: Advisory Panel – Marine Non-indigenous Species (MEQ)

Co-conveners: Thomas Therriault (Canada); Aibin Zhan (China); Joseph Krieger (USA)

Request: 1 to 1.5 days depending on location

Sponsorship: NOWPAP, ICES, US National Invasive Species Council (NISC), US Aquatic Nuisance Species Task Force (ANSTF) (all TBC once venue confirmed)

PICES will provide leadership to the United Nations Decade of Ocean Sciences for Sustainable Development and its mission of developing “the science we need for the ocean we want” through its science programs. The current FUTURE scientific program promotes investigations of North Pacific ecosystems with an emphasis on the synergy of social, ecological, and environmental systems and processes. Within this framework, PICES is focused on developing a better understanding of the combined consequences of climate change and anthropogenic pressures on marine ecosystems and services, and their marine-dependent social systems. Globally, non-indigenous species (NIS) are recognized as major ecosystem stressors which can cause ecological and economic damage to marine ecosystems and are a threat to biodiversity, ecosystem services, and the

livelihood of coastal communities around the North Pacific. The spread of marine NIS has increased in the last decade due to globalization and other related human activities such as climate change. An increased awareness about the threats NIS pose has resulted in a recognition for better management and policy to achieve sustainability goals. From aquaculture imports to commercial shipping to the catastrophic consequences of the Great East Japan Tsunami, there are many examples of NIS movements between the eastern and western Pacific and between the Pacific and all world oceans. In order to mitigate the risks posed by NIS to achieve greater sustainability of North Pacific ecosystems we must first learn from the past and present to make informed decisions about the future. The goal of this session is to share experiences around understanding, forecasting, assessing, and mitigating NIS that will inform future priorities on NIS for PICES member countries.