WORKING GROUP ON SCIENCE TO SUPPORT CONSERVATION, RESTORATION AND MANAGEMENT OF DIADROMOUS SPECIES (OUTPUTS FROM 2023 MEETING) (WGDIAD)

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i Executive summary

The 2023 WGDIAD meeting took place from 12th to 13th September at the Palacio Euskalduna in Bilbao, Spain, in a hybrid format with both in-person and remote participation. The meeting brought together 31 participants from nine member states, who engaged in discussions on the conservation and management of diadromous species, focusing on updates from four key expert groups: WGEEL, WGNAS, WGBAST, and WGTRUTTA. The meeting addressed critical topics such as eel stock assessments, salmon life-cycle modelling, sea trout population management, and the current status of Baltic salmon stocks.

A key presentation came from the Northern Hemisphere Pink Salmon Expert Working Group, which focused on the rapid and concerning range expansion of pink salmon (*Oncorhynchus gorbuscha*) into the North Atlantic and Arctic Oceans. Pink salmon, originally a Pacific species, has seen an unexpected increase in numbers in regions like Norway, Scotland, and even as far south as France. The group explored the ecological implications of this invasion, including potential competition with native species like Atlantic salmon and the effects on local ecosystems. The presentation also emphasized the importance of using tools like environmental DNA (eDNA) to monitor the spread of pink salmon and assess the long-term impacts of their establishment in non-native regions.

Additional presentations included updates from the GenMeMo Project on smelt genetics in the German Bight and the DIADes Project, which integrates ecological and economic research for the improved management of diadromous species. These presentations stimulated discussions on how these findings could be integrated into stock assessments and management strategies for migratory freshwater fish.

A major point of discussion during the meeting was the ongoing progress toward formalizing a Memorandum of Understanding (MoU) between the North Pacific Anadromous Fish Commission (NPAFC) and ICES, with a focus on fostering collaboration between Atlantic and Pacific salmon scientists. While progress has been slow, the meeting reaffirmed the commitment to building stronger ties through international collaboration.

The meeting also addressed future leadership within WGDIAD, with co-chair Hugo Maxwell calling for nominations to replace Dennis Ensing, whose second three-year term is ending. Maxwell emphasized the importance of nominating early career scientists, with nominations requested before the end of November 2023.

The 2023 WGDIAD meeting reinforced the group's role in coordinating international efforts to tackle the complex challenges facing diadromous species, including climate change, habitat loss, and interspecies competition. The meeting highlighted the importance of continued international cooperation, innovative monitoring techniques, and adaptive management strategies to safeguard the future of diadromous species.

ii Expert group information

Expert group name	Working Group on Science to Support Conservation, Restoration and Management of Diadromous Species (WGDIAD)
Expert group cycle	Multiannual fixed term
Year cycle started	2021
Reporting year in cycle	3/3
Chair(s)	Dennis Ensing, UK
	Hugo Maxwell, Ireland
Meeting venue and dates	12-13 September 2023, Palacio Euskalduna, Bilbao, Spain & Webex (31participants)

1 List of Outcomes and Achievements of the WG in this delivery period

1.1 Meetings held in 2022/2023

In 2022 and 2023, WGDIAD continued its role in facilitating meetings focused on the conservation and management of diadromous species. The 2022 annual WGDIAD meeting was held from 20-21 September at the Aviva Stadium in Dublin, Ireland, with additional participation remotely via MS Teams. Seventeen participants from nine countries attended, discussing key issues such as updates from expert groups including WGEEL, WGNAS, WGTRUTTA, and WGBAST. Additionally, WGDIAD participated in the Northern Hemisphere Pink Salmon Expert Group meeting on 02-03 October 2022 in Vancouver, Canada, ahead of the International Year of the Salmon (IYS) Synthesis Symposium. The meeting primarily focused on the rapid expansion of pink salmon into the North Atlantic and Arctic Oceans and its potential ecological impacts.

Intersessional meetings were also conducted between Vladimir Radchenko, outgoing Executive Director of NPAFC, with facilitation from Mark Saunders (NPAFC Secretariat, BECI), along with ICES Professional Officer Anne Cooper and WGDIAD chairs Hugo Maxwell and Dennis Ensing to discuss a potential Memorandum of Understanding (MoU) between NPAFC and WGDIAD/ICES. Such deliberative, in-person discussions were truly valuable as they laid the groundwork for future collaboration among scientists in the Arctic, Atlantic, and Pacific.

The 2023 WGDIAD annual meeting was held from 12-13 September at the Palacio Euskalduna in Bilbao, Spain, again in a hybrid format with remote participation via MS Teams. The meeting saw an increase in participation, with 31 attendees from nine member states. The meeting provided significant updates on the activities of expert groups including WGEEL, WGNAS, WGBAST, and WGTRUTTA, and the Northern Hemisphere Pink Salmon Expert Group, addressing critical topics such as eel stock assessments, salmon life-cycle modelling, and the management of sea trout populations. Notable presentations included research on smelt genetics, the progress of the DIADes Project, and discussions surrounding the expanding range of pink salmon. Ongoing efforts to formalize the MoU with NPAFC were also discussed, alongside broader issues related to habitat loss, climate change, and the challenges of interspecies competition. Both the 2022 and 2023 meetings reaffirmed WGDIAD's central role in coordinating international efforts to manage and conserve diadromous species amidst these evolving challenges.

1.2 Opening of annual meeting and adoption of the agenda

At the start of the 2023 WGDIAD meeting, participants were reminded of the ICES participation rules and code of conduct, particularly regarding behaviour. They were also asked to disclose any potential conflicts of interest before the meeting commenced. Following this, the itemized agenda was presented, with participants advised to raise any necessary changes either immediately or via email later. The agenda (Annex 2) for the annual meeting was accepted without any changes.

1.3 Summary Outcomes of the Meeting

The 2023 WGDIAD meeting, held in a hybrid format on 12-13 September at the Palacio Euskalduna in Bilbao, Spain, saw participation from 27 attendees representing nine member states. The meeting facilitated important discussions on the management and conservation of diadromous species, providing updates from key expert groups, including WGEEL, WGNAS, WGBAST, and WGTRUTTA. These groups addressed critical topics such as eel stock assessments, salmon life-cycle modelling, and sea trout population management.

Notable presentations included research on the GenMeMo project related to smelt genetics, the DIADes Project on diadromous species management, and the findings of the Northern Hemisphere Pink Salmon Expert Group, focusing on the species' rapid expansion into the Atlantic and Arctic Oceans and its ecological impacts. The group discussed the potential for integrating these findings into stock assessments and management strategies for migratory freshwater fish.

Another important outcome was the ongoing discussion of the Memorandum of Understanding (MoU) between NPAFC and WGDIAD/ICES. Although progress has been slow, the meeting reaffirmed the commitment to building stronger collaboration between Atlantic and Pacific salmon scientists. Participants also focused on addressing broader challenges such as habitat loss, climate change, and interspecies competition.

Looking forward, WGDIAD emphasized the importance of continuing these collaborative efforts and integrating new research and technologies, such as environmental DNA (eDNA) monitoring, to enhance the management of these species. The meeting also set the stage for continued work on data harmonization and improving stock assessment models in preparation for future challenges in diadromous species conservation.

Outcomes from meetings and activities during the last year include:

Collaboration Discussions:

Continued progress on discussions around the potential Memorandum of Understanding (MoU) between WGDIAD/ICES and the North Pacific Anadromous Fish Commission (NPAFC).

Intersessional meetings facilitated by Mark Saunders, involving NPAFC's Executive Director, ICES Professional Officer Anne Cooper, and WGDIAD co-chairs, focused on strengthening collaboration between Atlantic and Pacific salmon scientists.

Formalization of the MoU is ongoing, with a foundation for future joint research and data sharing being established.

Northern Hemisphere Pink Salmon Experts Group Meeting:

Held in October 2022, focusing on the rapid expansion of pink salmon in the North Atlantic and Arctic Oceans.

Addressed concerns about the potential impact of pink salmon on native species, particularly Atlantic salmon.

Highlighted the importance of monitoring interspecies interactions as pink salmon populations grow.

Data Collection and Integration:

Significant advancements were made in improving data collection and integration for diadromous species.

The Living Planet Index (LPI) for Migratory Freshwater Fish and the Unlocking the Severn Project provided valuable insights for restoration and management efforts.

International Year of the Salmon (IYS) Updates:

The Northern Hemisphere Pink Salmon Expert Group's 2022 meeting contributed to a better understanding of pink salmon range expansion.

Discussions focused on future collaborative efforts to address the impacts of climate change and habitat degradation on salmon populations across the Atlantic and Pacific Oceans.

2 Reviews of Expert Groups on Diadromous Species and Presentations from Additional Experts

During 2023, WGDIAD coordinated the activities of four Expert Groups and one Workshop related to diadromous species, including WGEEL, WGNAS, WGTRUTTA, WGBAST, and the Northern Hemisphere Pink Salmon Expert Group. These groups addressed critical issues such as salmon life-cycle modelling, eel stock assessments, and sea trout population management. WGEEL continued its work on assessing European eel populations, focusing on recruitment trends and stock recovery challenges. WGNAS provided updates on Atlantic salmon stocks, highlighting concerns over unreported catches and emerging threats like sea lice and infectious salmon anaemia (ISA). WGTRUTTA made significant progress in standardizing data collection for sea trout and advancing research on life history patterns, while WGBAST concentrated on the status of Baltic salmon and sea trout, with attention to habitat restoration and post-smolt survival rates.

The Northern Hemisphere Pink Salmon Expert Group's work was particularly relevant, given the ongoing expansion of pink salmon into the Atlantic and Arctic Oceans and its potential impact on native diadromous species. The group explored the ecological implications of this invasion and the need for enhanced monitoring, particularly through the use of environmental DNA (eDNA).

In addition to these expert groups, WGDIAD facilitated important presentations and discussions on key projects such as the GenMeMo project on smelt genetics, which examined the genetic diversity of smelt populations in the German Bight and the effects of environmental stressors. The DiadES project was also presented, highlighting the integration of ecological and economic research to improve diadromous species management, with tools like the Interactive Web Atlas (IWA) and the DiadESland game. These presentations were complemented by discussions on the integration of new data and findings into stock assessment processes, with an emphasis on improving data collection for migratory freshwater fish.

Summaries of these activities are presented below, along with notes from the post-presentation discussions held during the 2023 WGDIAD meeting, reflecting on future research needs and collaboration opportunities.

2.1 WGEEL – Joint EIFAAC/ICES/GFCM Working Group on Eel

The Joint EIFAAC/ICES/GFCM Working Group on Eels (WGEEL) held its 2023 meetings in two sessions: an online session from 4-8 September, and a hybrid session from the 25th of September to the 2nd of October in Helsinki, Finland. The meetings were attended by 47 participants, representing 22 countries.

The main objectives of the 2023 WGEEL meetings were to assess the state of the European eel population and its fisheries, evaluate biometric data, review the roadmap for eel stock management, and update recruitment data from coastal and marine habitats. The group also focused on new and emerging threats to eel populations, particularly in the Mediterranean region, where work is ongoing towards a long-term management plan under the General Fisheries Commission of the Mediterranean (GFCM).

Key findings from the 2023 assessment showed that eel recruitment remains critically low. Glass eel recruitment in the North Sea reached a historical minimum of 0.4% of 1960-1979 levels, while recruitment in other parts of Europe remained at 8.8% of historical levels. Yellow eel recruitment also showed a continued decline. These trends underscore the need for continued conservation efforts and more comprehensive management strategies for the recovery of the European eel stock.

The WGEEL also evaluated the implementation of the WKFEA roadmap, addressing issues related to data collection, landings, and restocking efforts. Workshops planned for late 2023 and 2024 will further develop these strategies, with an aim to improve the scientific basis for advice on eel stock management.

Notes from WGDIAD

Eel Recruitment Decline: The group discussed the concerning decline in eel recruitment, particularly the record low glass eel recruitment in the North Sea, which reached just 0.4% of the 1960-1979 levels. Recruitment in other parts of Europe was slightly better but still critically low at 8.8%. There was a recognition that despite ongoing efforts, the recruitment levels remain alarmingly low, necessitating further research and action to mitigate the factors driving this decline.

Data Collection Challenges: The presentation highlighted challenges in collecting consistent and comprehensive data, particularly for yellow and silver eel stocks. The group discussed the need for improved data collection methodologies and better integration of national datasets into the overall assessment. Participants stressed the importance of addressing gaps in data from certain regions and the need for more accurate reporting of fisheries landings and other anthropogenic impacts.

Stock Management and WKFEA Roadmap: Progress on the WKFEA roadmap, especially in improving biometric data collection and reconstructing historical landings, was discussed. The group noted that upcoming workshops in late 2023 and 2024 will be key to advancing these efforts.

Conservation Priorities: WGEEL's findings underscored the urgent need for continued and strengthened conservation efforts, especially considering the long-term decline in eel stocks. Discussions revolved around possible new conservation measures, including further restrictions on fisheries, habitat restoration, and more targeted restocking programs.

2.2 WGNAS - Working Group on North Atlantic Salmon

In 2023, the Working Group on North Atlantic Salmon (WGNAS) continued its critical work of assessing and monitoring the status of Atlantic salmon populations across the North Atlantic, focusing on the Northeast Atlantic (NEAC), North American Commission (NAC), and West Greenland Commission (WGC) areas. The group's primary tasks included reviewing catch data, identifying emerging threats to salmon conservation, and providing scientific advice for future management and conservation strategies. These efforts were guided by the questions posed by the North Atlantic Salmon Conservation Organization (NASCO), which plays a central role in the international regulation of salmon fisheries.

One of the key findings from the 2023 WGNAS report was that the total reported salmon catch in the North Atlantic amounted to 700 tonnes in 2022, reflecting a slight increase from the 691 tonnes reported in 2021. However, the issue of unreported catches remained a significant concern, with an estimated 202 tonnes of unreported salmon catches in 2022, an increase from 163

tonnes in the previous year. The unreported catches included legal under-reporting, non-reporting, and illegal catches, highlighting ongoing challenges in accurately assessing the total impact of fisheries on salmon populations. The report also provided a detailed overview of catch-and-release practices across different countries, noting significant variations. Catch-and-release rates were as low as 5% in France, while the UK (England and Wales) reported a rate of 96%, reflecting differing national approaches to salmon conservation.

WGNAS identified several emerging threats to Atlantic salmon populations that require urgent attention. Notably, infectious salmon anaemia (ISA) has been detected in Iceland, posing a significant threat to both wild and farmed salmon populations. Additionally, the continued impact of sea lice in Norway was highlighted as a growing concern, particularly as it affects both wild salmon and the aquaculture industry. The group also discussed the implications of a new treatment for *Gyrodactylus salaris* in Norway, which may have broader applications for combating this parasite in other regions. The potential risks of offshore fish farming in Norway were also raised as a significant factor impacting salmon conservation efforts.

WGNAS reviewed several ongoing research projects aimed at improving the understanding of Atlantic salmon marine survival and migration. Projects such as the ATLANTIC SALMON AT SEA initiative, along with satellite tagging in Greenland and acoustic tracking studies, were praised for their contributions to understanding the factors influencing marine survival rates and the spatial distribution of salmon at sea. These projects have provided valuable insights into the marine phase of salmon life cycles, a period that remains poorly understood yet is crucial for the overall management of salmon stocks. However, despite these efforts, the 2023 assessments indicated that many salmon populations remain at risk, particularly in the southern regions of the NEAC, where 1SW (one-sea-winter) returns reached the lowest levels on record.

A significant issue highlighted in the 2023 report was the continued bycatch of Atlantic salmon in pelagic and coastal fisheries. The group noted that since recommendations made in 2004-2005, there have been few advancements in reducing salmon bycatch. Monitoring of bycatch in these fisheries remains inadequate, with limited observer programs and poor detectability of salmon in the catch. WGNAS recommended that countries implement better bycatch monitoring technologies, such as the use of environmental DNA (eDNA) sampling, and standardize monitoring protocols across regions. This would help address the ongoing issue of salmon mortality due to bycatch in non-target fisheries, which remains a significant threat to stock recovery.

The status of salmon stocks was another area of concern, particularly for the Southern NEAC stock complex. The 1SW returns in this region were determined to be suffering reduced reproductive capacity, with the lowest numbers recorded in the time series. The Multi-Sea-Winter (MSW) returns also showed signs of declining reproductive capacity, though the trends were less clear than for 1SW fish. These findings underscored the need for more targeted conservation efforts, particularly in southern regions, where salmon populations are under the greatest pressure. Conservation measures, such as habitat restoration and stricter fisheries regulations, were discussed as potential avenues for improving stock health in these areas.

WGNAS also reviewed the use of conservation limits (CLs) and the challenges in achieving them, particularly in the Southern NEAC region. Many stocks are no longer meeting their conservation limits, a trend that raises concerns about the future of Atlantic salmon populations in the region. The group discussed the difficulties in balancing the needs of different fisheries, particularly coastal and pelagic fisheries, with the long-term conservation goals for salmon. While the total catches may have shown a slight increase, the underlying health of the salmon stocks remains fragile, and more robust management measures are required to ensure their recovery.

Notes from WGDIAD

Following the presentation by WGNAS, the WGDIAD group engaged in an in-depth discussion about several critical issues affecting the conservation and management of Atlantic salmon. A significant concern was the persistent problem of unreported catches, which had reached an estimated 202 tonnes in 2022, representing a substantial challenge for accurate stock assessments and effective management. WGDIAD members stressed the importance of improving detection and reporting mechanisms, particularly in regions where under-reporting is suspected, such as Russia and France. Another major topic of debate was the variability in catch-and-release practices across different countries. While the UK reported catch-and-release rates of up to 96%, France lagged far behind at just 5%, raising questions about the effectiveness of this conservation tool in improving salmon survival rates. The group highlighted the need for further studies on the survival rates of released fish, especially under warmer water conditions that could exacerbate stress. Emerging threats such as ISA and sea lice infestations in Norway also featured prominently in the discussion. The ongoing risks posed by salmon bycatch in pelagic and coastal fisheries were another point of concern, as the group noted that little progress had been made since earlier recommendations from 2004-2005. Members advocated for the adoption of more sophisticated monitoring technologies, such as environmental DNA (eDNA) sampling, to improve bycatch detection. The discussion also touched on the need for continued and expanded research into marine survival through projects like the ATLANTIC SALMON AT SEA initiative and satellite tagging in Greenland. These initiatives were praised for their contributions to understanding the marine phase of salmon life cycles, which remains a crucial yet poorly understood aspect of salmon management. Finally, WGDIAD members expressed concern over the declining status of southern NEAC stocks, particularly the record-low returns of one-sea-winter (1SW) fish, which pointed to the need for more aggressive conservation measures, including habitat restoration and stricter fisheries regulations, to ensure the long-term recovery of Atlantic salmon populations.

2.3 WGBAST – Working Group on Baltic Salmon and Trout

In 2023, WGBAST focused on assessing the status of Baltic salmon and sea trout across multiple subdivisions, including the Gulf of Bothnia, Main Basin, and Gulf of Finland. The group reported that total salmon catches have been declining since the 1990s, largely due to increased fishing restrictions, particularly in the southern Baltic. However, smolt production has remained relatively stable, with wild production close to 3 million smolts, and an additional 3.6 million hatchery-reared smolts released in 2023. Post-smolt survival rates, which have fluctuated between 10% and 20% since the mid-2000s, dropped to record lows in 2021, raising concerns about stock recovery. Despite these challenges, 15 out of 17 assessed wild salmon stocks in the Gulf of Bothnia and Main Basin were found to be at or above sustainable levels. However, weaker stocks in the eastern Main Basin and Gulf of Finland continue to face long-term environmental pressures. For sea trout, populations are generally stable, but specific areas, such as the Gulf of Bothnia and regions in Lithuania and Germany, remain weak due to both natural and anthropogenic pressures. Recommendations for fisheries management included reducing exploitation rates in critical areas and focusing on habitat restoration to support stock recovery.

Notes from WGDIAD

During the 2023 WGDIAD meeting, discussions related to WGBAST centred on the status of Baltic salmon and sea trout populations, focusing on the trends and challenges highlighted in the working group's report. WGDIAD members noted the significant progress made in stabilising wild salmon populations, particularly in the Gulf of Bothnia, where most stocks were deemed sustainable. However, concerns were raised about the weaker stocks in the Gulf of Finland and the southern Baltic, which continue to struggle due to environmental pressures and overfishing. The group emphasized the need for stronger conservation measures, particularly regarding habitat restoration and migration pathways, as some areas continue to experience low parr densities and increased mortality among returning spawners.

The WGDIAD group also discussed the implications of post-smolt survival rates, which have remained unstable and recently hit record lows. Members highlighted the importance of monitoring factors influencing post-smolt mortality, such as climate change and disease outbreaks, which have already impacted certain Baltic rivers. The group agreed that ongoing efforts to reduce exploitation rates and improve habitat conditions are crucial for the long-term recovery of weaker stocks. The discussion concluded with recommendations to maintain low exploitation rates in areas where stock recovery is underway while urging further research on sea trout populations in particularly vulnerable regions, such as the Gulf of Bothnia and certain coastal areas of Lithuania and Germany.

2.4 WGTRUTTA - Working Group to develop and test assessment methods for Sea trout populations (anadromous *Salmo trutta*)

WGTRUTTA is working with four new ToRs since the middle of 2020:

1. Describe the life history drivers and distribution of sympatric sea and freshwater trout populations;
2. Quantify the external pressures on trout populations in formats necessary to understand the state of local populations;
3. Develop a toolbox of methods to assess stock and population state, based on a suite of options, and suitable for a range of scenarios found across the natural range of the sea trout; and
4. Develop solutions to achieve sustainable governance of trout stocks.

The four ToRs are further broken down into a total of 16 deliverables. Some of these deliverables will be published in the form of peer-reviewed papers, while others will be reported on in the late 2024 final report (to be published prior to the WGTRUTTA - Gdansk meeting on 11-15 November 2024).

WGTRUTTA has made significant progress in 2022 and the first half of 2023. Over this period, the working group focused on refining data collection methods, particularly through workshops in Rennes, France, and Gothenburg, Sweden, where members worked on comparing juvenile trout data collection methods across countries. The group has made strides in understanding the pressures affecting sea trout, with research covering the species' genetic diversity, migratory behaviour, and habitat use. One key achievement was the mapping of sea trout populations across 1 250 Norwegian rivers, which provides critical data for conservation efforts.

WGTRUTTA also explored the importance of estuaries for sea trout and examined the impacts of environmental stressors, such as sea lice infestations, on life history traits. Additionally, members developed the Trout Habitat Scores (THS) model, which has been successfully applied in Sweden, Latvia, and Estonia. A smolt productivity model was also trialled, with promising results.

Looking ahead, WGTRUTTA will continue to focus on refining its assessment tools and improving international data harmonisation. Plans for 2024 include further development of stock recruitment models, continued collaboration with the EU's Regional Coordination Groups (RCG), and the integration of sea trout data into the EU's Data Collection Framework (DCF). The group is also considering the formation of new sub-groups to address specific research areas, such as governance and habitat restoration, and intends to further explore training opportunities in age reading, genetic tools, and habitat restoration.

WGTRUTTA has confirmed plans for a third 3-year term, during which it will continue developing sea trout science, emphasizing collaboration, standardization of data, and the creation of tools to improve stock and population assessments across its natural range.

Notes from WGDIAD

Following the presentation of WGTRUTTA's 2023 progress to WGDIAD, discussions focused on several key topics. One major point was the development of the Trout Habitat Scores (THS) model, which had been used to assess smolt production and juvenile carrying capacity in various regions. WGDIAD members discussed the model's broader application potential, particularly how it could be integrated into ongoing assessments of sea trout populations across Europe. Concerns were raised about the challenges of comparing juvenile trout data collection methods between countries, with WGTRUTTA members acknowledging the difficulties of harmonizing data due to regional differences in monitoring techniques.

The group also emphasized the need for more detailed studies on the impact of sea lice infestations on sea trout populations, particularly given the recent findings that increased sea lice burdens can significantly affect individual sea trout life histories. There was a strong interest in continuing to support international research collaborations, especially through the development of the MARIE SKŁODOWSKA-CURIE SUSTAINTROUT Doctoral Training Network. This initiative aims to foster interdisciplinary research and develop governance solutions to address the challenges facing sea trout populations across Europe.

Additionally, the discussions highlighted the importance of including sea trout in the EU's Data Collection Framework (DCF), noting that while progress had been made, an official data call was needed to ensure long-term investment in data collection. The group agreed that future work should prioritize the development of stock recruitment models and the implementation of quality assurance schemes for data collection.

2.5 GenMeMo Project – Analysing connectivity of spawning habitats and potential subpopulations of smelt (*Osmerus eperlanus*)

At the 2023 WGDIAD meeting, Julia Friese from the Thünen Institute of Sea Fisheries presented an overview of the GenMeMo Project, which focuses on developing new genetic methods for monitoring fish stocks, using the European smelt (*Osmerus eperlanus*) in the German Bight as a case study. The presentation covered the life history and migration of smelt populations, noting

the distinction between land-locked freshwater populations and anadromous migratory populations. Friese detailed the stressors impacting smelt, including river deepening, migration barriers, and habitat destruction. The project's research aims to determine if the estuaries of the Weser and Elbe rivers are populated by separate sub-populations that evolve independently, and whether there is genetic exchange between them. She also discussed the effects of various environmental stressors, such as temperature and suspended solids, on smelt's early life stages.

The most important takeaways from the presentation were the development of new genetic tools for stock assessment and the exploration of smelt's role as an indicator species for the ecological health of estuaries. The GenMeMo project is expected to contribute to better understanding the population dynamics and potential recovery strategies for smelt, a species currently classified as "near threatened" in Germany.

Notes from WGDIAD

Following the presentation, WGDIAD members discussed the implications of the project for broader estuarine management strategies. There was particular interest in the potential for smelt to serve as an indicator species of ecological status, given its sensitivity to environmental stressors. The group also discussed the challenges of unregulated fisheries and the need for effective monitoring to prevent further declines in smelt populations. WGDIAD members agreed that the genetic methods being developed could have applications beyond smelt, benefiting the monitoring of other migratory species facing similar environmental pressures.

2.6 The DiadES project: scientific knowledge and tools for the international management of diadromous species

At the 2023 WGDIAD meeting, Géraldine Lassalle and Patrick Lambert from INRAE (French National Institute for Agricultural Research) presented the DiadES Project, a multidisciplinary initiative aimed at enhancing the international management of diadromous species. The project, which ran from February 2019 to June 2023, involved 10 beneficiary partners and 20 associated partners, focusing on nine case studies and 11 species. The project was built on combining ecological and economic research to better understand diadromous species and their habitat needs, as well as the ecosystem services they provide.

The DiadES project has produced several important tools, including the Interactive Web Atlas (IWA), available at https://iwa.diades.org, which provides data on the current status of diadromous species and their ecosystems. Another significant development is the DiadESland serious (sub-genre) game, designed to explore different management strategies for diadromous species under changing environmental conditions, such as climate change. The project also highlighted the need for better habitat connectivity and more robust management policies tailored to specific regional challenges.

Notes from WGDIAD

The WGDIAD discussions centered on the project's practical applications and how the tools developed could support existing ICES frameworks for diadromous species management. Members noted the potential for the IWA to serve as a valuable resource for both scientists and managers by consolidating crucial data on species' population dynamics and migration patterns. The DiadESland serious game was also commended for its innovative approach to engaging stakeholders and educating the public on the complexities of managing species in the face of climate

change and other anthropogenic pressures. Overall, the group recognised the project's contributions to enhancing cross-border collaboration and creating tools that offer both scientific insight and practical solutions for the sustainable management of diadromous species.

2.7 Northern Hemisphere Pink Salmon Expert Working Group

At the 2023 WGDIAD meeting, Dennis Ensing delivered a detailed presentation on the findings of the Northern Hemisphere Pink Salmon Expert Group, which convened in October 2022 in Vancouver. The presentation primarily addressed the rapid and significant range expansion of pink salmon (*Oncorhynchus gorbuscha*) beyond their native Pacific Ocean habitat into the Arctic and Atlantic Oceans. The group reviewed the species' growing presence, particularly in the northern regions, including Norway, Scotland, and the Russian Arctic, where pink salmon have been increasingly recorded since the 1960s, but more prominently since 2017. This proliferation is now raising ecological concerns, particularly related to their interactions with native species such as Atlantic salmon (*Salmo salar*).

Pink salmon, one of the most abundant salmon species in the Pacific, follow a unique two-year lifecycle, with populations maturing and returning to spawn predominantly in odd-numbered years. This lifecycle creates a genetic distinctiveness between each generation and has likely contributed to their adaptability to new regions. Recent observations show that this adaptability, coupled with rising ocean temperatures driven by climate change, has facilitated their successful establishment far beyond their native Pacific range. In particular, warming waters in the North Atlantic and Arctic Oceans have been linked to the species' northward migration, allowing them to colonise new ecosystems and compete with native species.

The presentation emphasized the particular case of pink salmon colonization in northern Norway, where the species has established self-sustaining populations. These populations are now expanding into other parts of Europe, with sightings as far south as France. The ecological implications of this expansion were explored, noting both the potential benefits and risks. On the one hand, pink salmon carcasses can contribute nutrients to freshwater ecosystems, providing essential nutrients to species that rely on decaying organic matter. However, the more pressing concern is the competition they pose to native salmonids, including Atlantic salmon and sea trout (*Salmo trutta*). Pink salmon compete for food resources and spawning grounds, particularly in freshwater ecosystems where the habitat is already under stress from factors like pollution, damming, and habitat degradation.

Another major focus of the presentation was the impact of pink salmon on food webs, especially in marine environments. Pink salmon are primarily plankton feeders, and their high abundance in some regions may place additional pressure on already scarce food resources. This is especially concerning in regions like the North Atlantic, where native fish species are also heavily reliant on zooplankton. The experts warned that an overabundance of pink salmon could disrupt these delicate food webs, potentially leading to cascading effects on both commercial and ecologically important species, including native salmon populations.

Monitoring Efforts and Research Developments

To address the growing concerns around pink salmon expansion, the presentation highlighted ongoing research and monitoring efforts. One of the most promising developments is the use of environmental DNA (eDNA) monitoring, which allows researchers to detect the presence of

pink salmon in areas where they may be difficult to observe directly. eDNA techniques involve sampling water bodies to capture traces of genetic material left by pink salmon, offering a non-invasive and efficient way to track their spread. This method has proven particularly useful in remote areas, such as northern rivers, where traditional monitoring techniques may not be feasible.

In addition to eDNA, other monitoring approaches discussed included opportunistic marine surveys and localised monitoring efforts in rivers such as the Tana/Teno River, which borders Norway and Finland. These surveys have confirmed the increasing presence of pink salmon in rivers that are critical habitats for native species, raising alarms about the potential long-term impacts on these ecosystems.

Regional Responses

The presentation also explored the varied national responses to the pink salmon expansion. Norway, for example, has implemented an extensive eradication program, particularly in rivers where pink salmon threaten the habitats of native species. In contrast, Russia has largely embraced pink salmon as a resource, benefiting from their commercial value in fisheries. These contrasting approaches reflect differing national priorities and ecological contexts, but they also highlight the need for a more coordinated, international response to managing this invasive species. The presenters suggested that regional differences in pink salmon management require harmonised monitoring and data-sharing efforts to develop effective, cross-border management strategies.

Ecological Impact and Future Directions

As pink salmon continue to expand their range, understanding their ecological role becomes increasingly important. The presentation pointed out that although pink salmon have long been studied in their native Pacific habitats, their effects on ecosystems in the Arctic and Atlantic Oceans are still not well understood. The presenters stressed the importance of ongoing studies to assess the species' long-term ecological impacts, including its potential to disrupt local species and ecosystems. There was a call for more international collaboration to address these challenges, especially given the wide geographical range that pink salmon now occupy.

The presenter emphasized the importance of strengthening current monitoring programs and the need for continued research to better understand how pink salmon interact with other species, particularly Atlantic salmon. They also underscored the necessity of exploring management options that would mitigate the ecological impact of pink salmon while considering their potential value in fisheries. The presentation concluded by highlighting the urgent need for adaptive management strategies that can respond to the rapid changes being observed in pink salmon populations across the Northern Hemisphere.

Notes from WGDIAD

WGDIAD had a robust discussion following the presentation, focusing on the implications of pink salmon as an invasive species, particularly in the North Atlantic. There were concerns about the competition between pink salmon and native salmonid species, especially in spawning areas. The group also discussed the variability in national responses, noting that countries like Norway have implemented extensive eradication programs, while others, such as Russia, manage pink salmon as a resource. Members emphasized the need for more consistent international management strategies and better monitoring approaches to understand the long-term impacts of pink salmon on native ecosystems. Additionally, there was a strong interest in exploring potential collaborations between ICES, NPAFC, and other organizations to improve data sharing and develop coordinated management responses to the expanding pink salmon population.

This presentation and subsequent discussion highlighted the importance of continued monitoring and international cooperation in managing pink salmon, given their expanding presence and potential ecological impacts.

3 New Expert Groups

No new Expert Groups were formally proposed for 2023.

4 Theme Sessions and Symposia

4.1 Theme sessions

At the 2022 WGDIAD meeting, a theme session proposal titled "Advances in Ecosystem-Scale Strategies for Sustainable Governance of Diadromous Species" was discussed. This proposal, originally structured around combining ecological, social, and economic sciences, aimed to explore holistic management strategies for diadromous species and stocks. The theme session was designed to bring together experts from multiple disciplines to address the sustainable governance of these species, with a focus on balancing conservation with the socio-economic needs of fisheries management.

The proposal was meant to address three key topics:

1. The integration of ecological, social, and economic management objectives for diadromous species to identify target audience requirements for sustainable governance.
2. Establishing acceptable levels of social and economic risk for fisheries management, especially in relation to setting stock reference points and how to quantify these risks.
3. Exploring management strategies that could meet social and economic goals while ensuring biological sustainability for diadromous species.

However, despite the relevance of the topic, the theme session proposal was not successful for the 2023 ICES ASC. There are plans to revisit the proposal in 2024 and host a session in a future term given the absence of a diadromous themed session since the 2021 ASC.

4.2 Symposia

There were no proposals for symposia at the September 2023 WGDIAD meeting.

5 Proposals for Publications

There were no specific proposals for publications.

6 Update from the Intersessional Subgroup on Diadromous Fishes (ISSG Diadromous) – under the Regional Coordination Group for North Atlantic, North Sea & Eastern Arctic (RCG NANSEA)

At the 2023 WGDIAD meeting, Marko Freese and Tapani Pakarinen, representing the Intersessional Subgroup on Diadromous Fishes (ISSG Diadromous) under the RCG NANSEA, presented updates on their ongoing work. The presentation focused on the challenges in data collection and usage for diadromous species, particularly salmon, eel, and sea trout, across the North Atlantic and Baltic regions. The presenters highlighted the issues with stock status and fishing opportunities for these species, noting that many data collection requirements under the Data Collection Framework (DCF) have been in place since 2007 but are still underutilized for international stock assessments.

One of the main themes of the presentation was the need for better coordination between data collection efforts and the needs of ICES expert groups, such as WGNAS, WGEEL, WGBAST, and WGTRUTTA. The presenters also pointed out that although data for diadromous species are collected under the DCF, a significant portion of this data is not yet being fully utilized by the ICES working groups responsible for stock assessments. Additionally, they raised the potential for the Regional Database and Estimation System (RDBES) to host diadromous data centrally, which could enhance the consistency and availability of these datasets for broader use.

Notes from WGDIAD

Following the presentation, WGDIAD discussions focused on improving data use and harmonization across regions. Members considered the feasibility of using RDBES as a central repository for diadromous species data, particularly for non-commercial datasets like smolt, parr, and yellow eel abundance collected through fisheries-independent surveys such as electrofishing. There was also some interest in developing regional work plans (RWPs) to integrate this data better into stock assessments and management. WGDIAD members supported the continued development of spatial models for salmon and eel to enhance the accuracy of regional assessments, especially in the context of climate change.

The group stressed the importance of ongoing collaboration between ISSG Diadromous and ICES expert groups, particularly in harmonizing data collection methods like standardized electrofishing surveys. The need for a new co-chair for ISSG Diadromous was also raised, reflecting an effort to strengthen leadership. WGDIAD members acknowledged the vital role of this subgroup in addressing the complex management challenges facing diadromous species across Europe.

These discussions underscored the need for better data integration and regional collaboration to adapt to environmental changes impacting diadromous species.

7 Species

7.1 Participation in Fisheries Resources Steering Group (FRSG) meeting during the ASC

Hugo Maxwell attended the 2023 Fisheries Resources Steering Group (FRSG) meeting on 12 September 2023 on behalf of WGDIAD.

8 Any other business

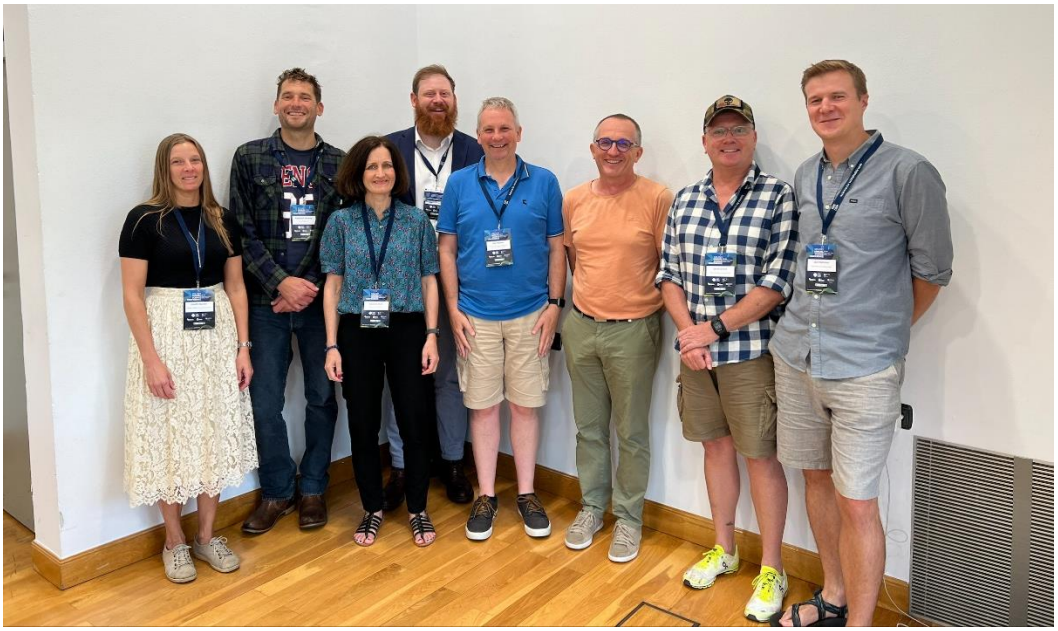
Request for chair nominations

At the 2023 WGDIAD meeting, the chair announced the need for nominations to replace Dennis Ensing, who will be stepping down at the end of his second three-year term as co-chair of WGDIAD. The current chair emphasized the importance of putting forward early career scientists for the position, highlighting the need for fresh perspectives and future leadership within the group. As no nominations were proposed during the meeting, he encouraged all members to submit potential candidates to him by the end of November 2023, ensuring sufficient time for the transition and continuity of leadership.

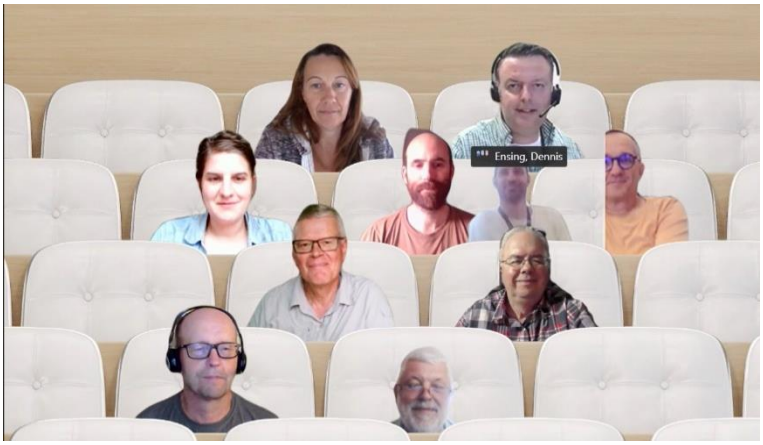
9 Next meeting

The next hybrid WGDIAD meeting was scheduled to take place at the 2024 ICES ASC at the Glasshouse in Gateshead, United Kingdom, from 09-12 September, with WGDIAD convening on the morning of Tuesday, 10 September. However, the meeting was cancelled. Therefore, the next meeting will be held at the 2025 ICES ASC at the Klaipėda University in Lithuania, from 15-18 September.

10 Group Pictures from WGDIAD hybrid meeting in Bilbao, Spain 12th and 13th of September 2023.



Members attending WGDIAD 2023 meeting in person in Bilbao, Spain (ICES ASC), 12th and 13th of September (partial group).



Members attending WGDIAD 2023 meeting online, 12th and 13th of September 2023 (partial group).

References

Government of Greenland. 2021. Management Plan for Atlantic salmon in Greenland. 21 p. https://naalakkersuisut.gl/~/media/Nanoq/Files/Attached%20Files/Fiskeri_Fangst_Landbrug/Eng/2021/forvaltningsplan_Laks_ENG.pdf. Accessed February 1, 2022.

Annex 1: List of participants

Name	Institute	Country (of institute)
Alan Walker	Cefas	UK
Anne Cooper	ICES	Denmark
Atanas Kontautas	Klaipeda University	Lithuania
Atso Romakkaniemi	Natural Resources Institute Finland (Luke)	Finland
Caroline Durif	IMR Norway	Norway
Catarina Mateus	University of Évora	Portugal
Cindy Breau	Fisheries and Oceans Canada	Canada
David Meerburg	Atlantic Salmon Federation	Canada
Dennis Ensing (co-chair)	Agri-Food and Biosciences Institute, Belfast	UK
Derek Evans	AFBI	UK
Elvira de Eyto	Marine Institute	Ireland
Guillaume Dauphin	Fisheries and Oceans Canada	Canada
Henrik Sparholt	University of Copenhagen	Denmark
Hugo Maxwell (co-chair)	Marine Institute	Ireland
Jan-Dag Pohlmann	Thuenen Institute	Germany
Jani Helminen	LUKE	Finland
Johan Dannewitz	Swedish University of Agricultural Sciences	Sweden
Johan Höjesjö	University of Gothenburg	Sweden
Jonathan White	Marine Institute	Ireland
Josefin Sundin	Swedish University of Agricultural Sciences	Sweden
Joshka Kauffman	Marine Institute	Ireland
Julia Friese	Thuenen Institute	Germany
Karen Dunmall	Department of Fisheries & Oceans	Canada
Karen Wilson	University of Southern Maine	USA
Kathy Mills	Gulf of Maine Research Institute	USA
MacKenzie Kermoade	ICES	Denmark

Name	Institute	Country (of institute)
Marko Freese	Thuenen Institute	Germany
Martin Kesler	University of Tartu	Estonia
Niels Jepsen	Technical University of Denmark (DTU Aqua)	Denmark
Patrick Lambert	INRAE	France
Randolph Velterop	Natural England	UK
Scott Roloson	University of PEI	Canada
Tapani Pakarinen	LUKE	Finland

Annex 2: Agenda for WGDIAD 2023

Annual meeting - Working Group on Science to Support Conservation, Restoration and Management of Diadromous Species [WGDIAD]

Chair: Dennis Ensing & Hugo Maxwell

12 – 13 September 2023 13.00-17.00 (GMT+2) Room no. 3B (Tuesday) and 5D (Wednesday), Palacio Euskalduna, Bilbao, Basque Country, Spain & remotely by MS Teams

Agenda:

Tuesday September 12th

13.00 – 13.15 Welcome and Introductions

13.15 – 13.30 Adoption of the Agenda and Appointment of a Rapporteur/Rapporteurs

13.30 – 13.45 WGDIAD ToRs for 2022 to 2024 – Dennis Ensing

13.45 – 14.00 Intersessional Activities 2021-2022 – Dennis Ensing

14.00 - 14.45 Presentation and discussion WGTRUTTA - Working Group to develop and test assessment methods for Sea trout populations (anadromous *Salmo trutta*): Alan Walker

14:45 – 15.30 Presentation and discussion WGNAS and WGNAS Benchmark - Working Group on North Atlantic Salmon: Alan Walker

15.30 – 16.00 Break

16.00 – 16.30 Julie Friese – Presentation and discussion on smelts

16.30 – 17.00 Presentation and discussion IYS & ICES/NPAFC Pink salmon expert group meeting Vancouver: Dennis Ensing

Wednesday September 21st

13.00-13:30 The DiadES project: scientific knowledge and tools for the international management of diadromous species: Patrick Lambert

13:30-14:00: Strategic Infrastructure for Improved Animal Tracking in European Seas (STRAITS): Sarah McLean

14.00-14.30 Update from the EU DCF Regional Coordination Groups Intersessional Group Diadromous fish (ISSG Diad): Marko Freese/Tapani Pakarinen

14.30-15.00 Break

15.00-15.30 Presentation and discussion WGEEL – EIFAAC/ICES/GFCM Joint Working Group on Eel: Jan-Dag Pohlmann

15.30-16:00 Presentation and discussion WGBAST – Working Group on Baltic Salmon and Trout: Johan Dannewitz

16.00-16.30 ASC Theme session proposals

16.30-17.00 Any Other Business

- Proposals for new chair for 2024 meeting. Vote required if more than 1 nomination.
- Input on new location and or timing for WGDIAD going forward.

17.00 Close meeting