WORKING GROUP ON SCIENCE TO SUPPORT CONSERVATION, RESTORATION AND MANAGEMENT OF DIADROMOUS SPECIES (WGDIAD; OUTPUTS FROM 2021 MEETING)

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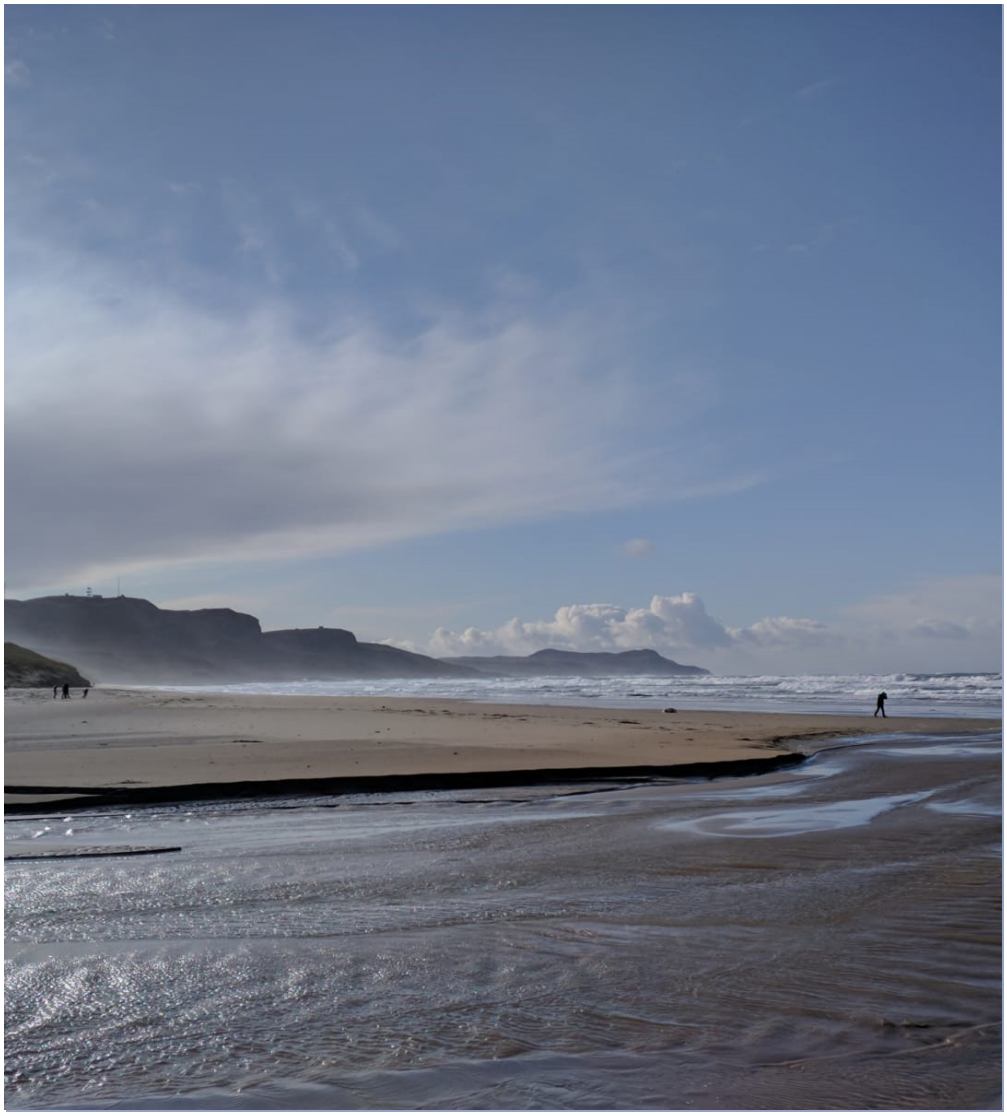

ICES INTERNATIONAL COUNCIL FOR THE EXPLORATION OF THE SEA
CIEM CONSEIL INTERNATIONAL POUR L'EXPLORATION DE LA MER

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i Executive summary

Working Group on Science to Support Conservation, Restoration and Management of Diadromous Species (WGDIAD, formerly WGRECORDS), was established to provide a forum for the coordination of work on diadromous species following the disbanding of the Diadromous Fish Committee. The role of the Group is to coordinate work on diadromous species, organise Expert Groups, Theme Sessions and Symposia, and help to deliver the ICES Science Plan. The annual meeting of WGDIAD was remotely held (by WebEx) 30 August – 2 September 2021.

The Annual Meeting received reports from ICES Expert Groups and workshops working on diadromous species, and considered their progress and future requirements. During the meeting, the following areas were discussed in more detail:

- Outcomes and deliverables from ICES EGs on diadromous fish during the last year;
- A progress report on the International Year of the Salmon (IYS);
- A progress report of the work of the Intersessional Subgroup Diadromous fish (ISSG Diad) of the Regional Coordination Groups (RCGs). The subgroup has a coordinating function and identifies data collection needs for diadromous species in relation to the EU Data Collection Multi-Annual Programme (DC-MAP);
- The ongoing work within ICES to develop and implement a new Life-cycle Model for Atlantic salmon assessment in WGNAS;
- A theme session proposal for the ICES ASC 2023, to be submitted in 2022, on exotic species (and stocks) and their impact on native species and their fisheries;
- Potential topics for future WGDIAD symposia;
- A report of the ICES WGDIAD/North Pacific Anadromous Fish Commission (NPAFC) Pacific/Atlantic salmon Round Table meeting on 1 September 2021, bringing together salmon scientists from the Pacific and Atlantic Ocean basins;
- Reports and updates from Unlocking the Severn Project and the Living Planet Index (LPI) For Migratory Freshwater Fish.

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	1/1
Chairs	Dennis Ensing, UK
	Hugo Maxwell, Ireland
Meeting venue and dates	30 August – 2 September 2021, Online, (22 participants)

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

1.1 Meetings held in 2021

The Working Group on Science to Support Conservation, Restoration and Management of Diadromous Species (WGDIAD, formerly WGRECORDS) was established to provide a scientific forum in ICES for the coordination of work on diadromous species. The role of the Group is to coordinate work on diadromous species, organise Expert Groups, Theme Sessions and Symposia, and help to deliver the ICES Science Plan.

The annual meeting of WGDIAD was held remotely (by WebEx) from 30 August – 2 September 2021, and chaired by Hugo Maxwell (Ireland) and Dennis Ensing (UK). There were 22 participants in total from 10 countries (Annex 1) who participated in the meeting for at least one of the days.

On 1 September 2021 WGDIAD held a joined meeting with the North Pacific Anadromous Fish Commission (NPAFC), the Pacific/Atlantic salmon Round Table. This event was attended by 68 people working on salmon in the Pacific or Atlantic Ocean basins. A report of this meeting can be found in section 9.3 of this document.

1.2 Opening of annual meeting and adoption of the agenda

The agenda (Annex 2) for the annual meeting was adopted.

1.3 Summary Outcomes of the Meeting

Outcomes from meetings and activities during the last year include:

- Compilation and discussion of work carried out by EG's under the WGDIAD umbrella, and consideration of their progress and future requirements;
- Coordination of a proposal for a theme session at ICES ASC in 2022, focusing on exotic species and their impact on native species and fisheries for native species;
- Links with other relevant EGs in ICES;
- An update on the Unlocking the Severn Project by Natural England;
- An update on the International Year of the Salmon (IYS);
- An update from the Regional Coordination Group (RCG) Intersessional Sub Group Diadromous Fish (ISSG Diad) meetings held at 2020;
- A discussion on the Living Planet Index (LPI) For Migratory Freshwater Fish Report;
- A Pacific/Atlantic salmon Round Table meeting with the Pacific diadromous fish scientific community.

2 Reviews of Expert Groups on Diadromous Species

During 2021, WGDIAD has coordinated the activities of four Expert Groups and one Workshops related to diadromous species, including three ACOM EGs and one ACOM Workshops. Separate summaries are presented below. At the end of the summaries, notes from the post-presentation discussions at the WGDIAD meeting have been added for the record.

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

The Joint EIFAAC/ICES/GFCM Working group on eels (WGEEL) met by correspondence and video conference from September 7–10 September and 27 September – 4 October in 2021 to assess the state of the European eel and its fisheries, investigate the effects of contaminants on the reproductive capacity of the eel stock, discuss the findings of WKFEA, further identify issues specific to the Mediterranean region and report on any updates to the scientific basis of the advice, new and emerging threats or opportunities. For a better integration of the Mediterranean area, new members joined WGEEL, providing data and support as regional experts. This is considered an important step in a continuous process to identify and address Mediterranean-specific issues and harmonize the efforts of WGEEL and the recent 'GFCM research Programme on European Eel'. The recruitment of European eel strongly declined from 1980–2011. The glass eel recruitment compared to that in 1960–1979 in the "North Sea" index area was 0.6% in 2021 (provisional) and 0.9 % in 2020 (final). In the "Elsewhere Europe" index series it was 5.4 % in 2021 (provisional) and 7.1% in 2020 (final), based on available data-series. For the yellow eel data-series, recruitment for 2020 was 16% (final) of the 1960–1979 level; the 2021 data collection for yellow eel is ongoing. Time-series from 1980–2021 show that recruitment has stopped decreasing in 2011 but the trend thereafter is rather unclear. Preliminary analyses of 160 data-series on yellow or silver eel abundance show the potential of the yellow and silver eels' series to improve the stock assessment. A comprehensive framework of analyses of the yellow and silver stocks through these series will, however, require many iterations of data collection, analyses and further data needs. Mortality and biomass indicators have been reviewed and visualized, preparing for a future workshop on the evaluation of eel management plans (WKEMP). Spatial overviews and temporal trends show a lack of data for many regions and no evidence yet of a general improvement in stock status for regions with data. Overall silver eel escapement remains low and mortalities high. Doubts remain about the consistency of indicators across countries. The information provided on data and methods used for assessment are not available or sufficiently detailed to ensure transparency and reproducibility of estimates. These limitations and the incomplete reporting impair the use of these data to inform on the status of the stock at a larger scale. A review on the effects of contaminants (in a broader sense: spawner quality) on the reproductive capacity of eel highlighted this as an important, but a frequently lacking, aspect of stock assessment. Monitoring of silver eel quality should be considered as part of new or existing programmes. WGEEL supports the findings WKFEA and the suggested roadmap and agreed to implement the necessary steps towards achieving it. This implies further exploration and analyses of existing as well as the systematic collection of additional data. Implementation will require concerted data collection and assessment, which will require additional support. In summary, the working group has focused on exploring and analysing the data collected in the WGEEL database for their potential use in stock assessment. This included identifying gaps in the available data, defining data requirements for specific analyses in future and developing procedures for the analysis of these data. Furthermore, the group reviewed the effects of contamination on the reproductive potential

of eels and renewed their recommendation to consider these in the assessment of effective spawning-stock biomass.

Notes from WGDIAD

The group could not discuss the 2021 WGEEL report as the 2021 WGEEL meeting was held after the WGDIAD meeting, as is the case most years. WGDIAD was given a presentation of the 2020 WGEEL report at the meeting.

2.2 WKSalModel – Workshop for Salmon Life Cycle Modelling

The Workshop for Salmon Life Cycle Modelling (WKSalModel), co-chaired by Etienne Rivot (France), Gérald Chaput (Canada) and Dennis Ensing (UK) met by web conference 5–8 January 2021 to develop competencies in using a newly developed Life Cycle Model (LCM) and to formalize the workflow of the new modelling framework for assessing and providing fisheries catch advice for Atlantic salmon stocks in the North Atlantic. The workshop reviewed the LCM which incorporates all stocks of Atlantic salmon at the North Atlantic scale in a single model, reviewed comparisons of current ICES PFA models and the LCM approach, and discussed the data inputs and process for running the LCM. The LCM framework is embedded within a suite of R programs and a shiny web application that has been made available online that simplifies and strengthens the robustness of the stock assessment workflow from the input data to the production of catch advice. Timelines for providing data from jurisdictions for input to the LCM were discussed and it was indicated that data from jurisdictions are generally not ready until March of the assessment year, which strengthens the need to have automated processes for the ICES PFA model and the new LCM processes. The decision was made at the workshop to provide the required assessment and provision of catch advice in March 2021 based on the previous PFA models used by ICES. The LCM would be run in parallel and the results of the PFA model and LCM outputs compared. A follow-up workshop is proposed for late 2021/early 2022 to prepare the elements of LCM and PFA model descriptions, data inputs, and workflow processes in preparation for a proposed ICES benchmark process in 2022.

Notes from WGDIAD

The group discussed the report and some comments/suggestions were made:

- The LSF should perhaps try to take in data from the freshwater phase of the lifecycle too as it can have knock on effects on the later marine phase of the fish's lifecycle.
- As WGBAST and WGNAS both employ LSF-type models these groups should exchange ideas on how to deal with problems and caveats. Maybe ICES can facilitate this.
- It takes a large effort currently to run the WGBAST model, with only two members capable of making changes to the model if it experiences problems. WGNAS should be aware of this and try to train a larger group of experts able to run the model correctly.

2.3 WGBAST – Working Group on Baltic Salmon and Trout

The Baltic Salmon and Trout Assessment Working Group (WGBAST) chaired by Martin Kessler (Estonia) met remotely (by WebEx), 22–30 March 2021. A total of 28 experts from all nine Baltic Sea countries attended the meeting.

WGBAST was mandated to assess the status of salmon in Gulf of Bothnia and Main Basin (subdivisions 22–31), Gulf of Finland (Subdivision 32) and sea trout in subdivisions 22–32, and to propose consequent management advices for fisheries in 2022. Salmon in subdivision 22–31 were assessed using Bayesian methodology with a stock projection model (data up to 2020) for evaluating impacts of different catch options on the wild river stocks.

- Total salmon catches have decreased continuously since the 1990s. The fishery related mortality for salmon in 2020 (including estimates of unreported, misreported and discarded catches and recently revised estimates for recreational trolling) was similar compared to 2019. This is mainly due to significant decrease of misreporting in the open sea fishery. Reported efforts in commercial salmon fisheries have also remained on a low level.
- The level of estimated misreporting of salmon as sea trout remained on a very low level just as in 2019.
- The share of recreational catches of Baltic salmon in sea and rivers has increased over time, and at present they represent about half of the total fishing mortality. In particular, the offshore trolling fishery for salmon has developed rapidly since the 1990s and early 2000s. According to updated estimates, the total landed (retained) catch from recreational trolling has in recent years ranged from about 15 000 to 25 000 salmon per year.
- Since the 1990s, production of wild salmon smolts has gradually increased in the Gulf of Bothnia and Gulf of Finland. For most rivers in Gulf of Bothnia smolt production is predicted to increase slightly in 2021. Long-term trends for smolt production in southern Main Basin rivers have remained stable or slightly decreasing.
- The current (2020) total wild production in all Baltic Sea rivers is about 2.7 million smolts, corresponding to about 71% of overall potential smolt production capacity. In addition, about 4.7 million hatchery reared smolts were released into the Baltic Sea in 2020.
- Out of 17 analytically assessed wild salmon stocks, seven have reached MSY level with very high certainty, especially in the northern Baltic Sea.
- In the Gulf of Finland, wild Estonian rivers show recovery. As assessed previously, most weak stocks are located in the Main Basin. Several of the rivers in this area are far below a good state and have showed a negative development in recent years.
- The exploitation rate of Baltic salmon in the commercial sea fisheries has been reduced to such a low level that most stocks (for which analytical projections are currently available) are predicted to maintain present status or recover at current levels of fishing pressure and natural mortality. However, due to local environmental issues, many weak stocks are not expected to recover without longer term stock-specific rebuilding measures, including fisheries restrictions in estuaries and rivers, habitat restoration and removal of potential migration obstacles. In particular, nearly all Main Basin stocks require such measures.
- M74-related juvenile salmon mortality increased in hatching years 2016–2018, but is expected to remain very low in spring 2021. It is hard to predict future levels of M74. Recent disease outbreaks and fish with apparent lack of energy, resulting in large numbers of dead spawners and low parr densities in some wild rivers, is another future concern. Most alarming is the situation in Vindelälven and Ljungan where parr densities have collapsed. Despite ongoing research, the reason(s) behind the deteriorating salmon health remains largely unknown.
- Positive development for sea trout in the Gulf of Finland and Baltic Sea eastern region, but many populations are still considered vulnerable. Stocks in the Gulf of Bothnia are particularly weak, although spawner numbers and parr densities show signs of improvement. Negative trend is evident in southern part of the Baltic Sea. Populations in Lithuania and Germany are weak, however, probably in part due to natural causes, but they are also affected by coastal fishing.

- In general, exploitation rates in most fisheries that catch sea trout in the Baltic Sea area should be reduced. This also holds for fisheries of other species where sea trout is caught as bycatch. In regions where stock status is good, existing fishing restrictions should be maintained in order to retain the present situation.

Notes from WGDIAD

The group discussed the current issues with the advice in WGBAST around the issue of the mixed-stock fishery in the southern Baltic.

ICES noted it would like to see more formal links between WGBAST and WGNAS, especially to support each other on the modelling side of the assessments. The chairs of both EGs welcomed the idea and suggested exchanging information on the timing of their respective meetings and perhaps be present at each other's meetings.

2.4 WGNAS – Working Group on North Atlantic Salmon

The Working Group on North Atlantic Salmon (WGNAS) (chaired by Dennis Ensing, UK) met via web conference 22–31 March 2021 to address questions posed to ICES by the North Atlantic Salmon Conservation Organisation (NASCO). There were in total 34 participants, representing 12 countries from North American Commission (NAC) area and the North-East Atlantic Commission (NEAC) area: Canada, USA, Iceland, Norway, Finland, Ireland, UK (England & Wales), UK (Scotland), UK (Northern Ireland), and France. One of the participants was an observer from NASCO. Information was also provided by correspondence from Faroes and Spain for use by the Working Group.

WGNAS met to consider questions posed to ICES by NASCO and also generic questions for regional and species Working Groups posed by ICES.

In summary of the findings of the Working group on North Atlantic Salmon:

- In the North Atlantic, exploitation rates on Atlantic salmon continue to be among the lowest in the time-series.
- Nominal catch in 2020 was 915 t. This was 30 t above the updated catch for 2019 (885 t) but 197 and 346 t below the previous five- and ten-year means, respectively.
- The provisional estimate of farmed Atlantic salmon production in the North Atlantic area for 2020 is 1821 kt, which is an increase on the production for 2019 (1771 kt) and the previous five-year mean (1627 kt). The production of farmed Atlantic salmon in this area has been over one million tonnes since 2009. The total worldwide production in 2020 is provisionally estimated at around 2638 kt which was almost 3000 times the catch of wild Atlantic salmon.
- The provisional nominal catch in the NEAC area in 2020 (778 t) was slightly higher than the updated catch for 2019 (755 t) and 19% and 29% below the previous five-year and ten-year means, respectively.
- The Working Group reported on the findings of a study on the performance of fishery sampling programmes to estimate catches of low-proportions of non-local origin salmon in mixed-stock fisheries and on a catchment-wide international coordinated genetic monitoring programme of reintroduced Atlantic salmon on the River Rhine.
- A number of threats were discussed including diseases and parasite events in Ireland (Red Skin Disease) and UK (Northern Ireland) (river lamprey), and exotic salmonids (pink salmon) in northern Finland.
- The Working Group received an update on the progress of the development of the new Bayesian Life Cycle Model (LCM) that has been proposed to improve the biological real-

ism of the stock assessment model used by WGNAS. A workshop (WKSalModel) to advance this process convened in January 2021 to familiarise experts with the methodological framework used for providing catch advice based on the LSM, and to discuss and formalise the workflow. Finally, next steps and timelines for data inputs for the use of the LSM in the proposed 2022 WGNAS Benchmark were discussed.

- The impact of the coronavirus (COVID-19) pandemic was not consistent among jurisdictions with respect to Atlantic salmon fisheries and ICES WGNAS participants' ability to report 2020 Atlantic salmon catches and status of stocks. There was little or no impact reported for UK (Northern Ireland), Ireland, Iceland, Norway, Sweden and Denmark. In other jurisdictions, stay-at-home orders and travel restrictions affected fishing effort, Atlantic salmon population monitoring activities and delayed the collection of fisheries statistics.
- Northern NEAC stock complexes, prior to the commencement of distant-water fisheries, were considered to be at full reproductive capacity. The southern NEAC stock complexes were also considered to be at full reproductive capacity in the latest PFA year, although this is due, at least in part, to changes in the UK (Northern Ireland) and UK (Scotland) SERs and CLs.
- Catch advice for the Faroes fishery was developed for the 2021/2022 to 2023/2024 fishing seasons. In the Northern NEAC stock complex, over the forecast period, the non-maturing 1SW component has a high probability (≥95%) of achieving its SER for TACs at Faroes solely for a catch option of ≤20 t in the 2021/2022 season. The maturing 1SW component in the Northern NEAC stock complex and both Southern NEAC stock complex components each have less than 95% probability of achieving their SERs with any TAC option in any of the forecast seasons. Therefore, there are no catch options that ensure a greater than 95% probability of each stock complex achieving its SER.
- The probabilities of the non-maturing 1SW national management units achieving their SERs in 2021/2022 vary between 20% (UK, Northern Ireland) and 99% (Norway) with zero catch allocated for the Faroes fishery and decline with increasing TAC options. The only countries to have a greater than 95% probability of achieving their SERs with catch options for Faroes are Norway (TACs ≤40 t) and UK (England & Wales) (TACs ≤40 t). In most countries, these probabilities are lower in the subsequent two seasons. There are, therefore, no TAC options at which all management units would have a greater than 95% probability of achieving their SERs.
- In the NAC area, the 2020 provisional harvest in Canada was 104 t, approximately 4% higher than the finalised 2019 harvest of 100 t and the third lowest in the time-series since 1960. The majority of harvest fisheries on NAC stocks were directed toward small salmon. In recreational fisheries, large salmon could only be retained on 20 rivers in Québec.
- In 2020, 2SW returns to rivers for all regions of NAC were suffering reduced reproductive capacity, with the exception of the Gulf region in Canada.
- The continued low and declining abundance of salmon stocks across North America, despite significant fishery reductions, strengthens the conclusions that factors acting on survival in the first and second years at sea, at both local and broad ocean scales are constraining abundance of Atlantic salmon.
- In Greenland, a total catch of 31.7 t was reported for 2020 compared to 29.8 t in 2019. Data on continent or region of origin were not available for 2020 due to a lack of available samples.
- At West Greenland there are no mixed-stock fishery catch options for 2021, 2022, or 2023 that would be consistent with a chance of 75% or greater of simultaneously attaining management objectives for the seven stock complexes.

- The two Indicator Frameworks developed previously by the Working Group to be used to check on the status of the NAC and NEAC stocks in the interim years of the multiannual catch advice cycle were updated and are available to be used any new multi-year agreements for the fisheries at Greenland and the Faroes, respectively.

Notes from WGDIAD

A discussion was had about the (timing of) the WGNAS benchmark in relation to WGNAS having to do another full assessment in 2022. The WGNAS chair explained the benchmark will now likely be postponed until 2023, but scoping meeting will start in 2022 preparing for the benchmark.

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

WGTRUTTA held two meetings during 2021, both remotely by WebEx. Workshop number two was held from 19–21 January, Workshop number three from 29 June – 1 July.

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.
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 2023 final report.

Agreed actions for 2021/2022 are:

- Link with the ISSG Diad (on the data workshop) and other data workshops on for example scale reading and calibration.
- Develop advice on data requirements to apply stock-recruit type assessment to new stocks.
- Develop advice on how and where to use data poor tools.
- Further test the Trout Habitat Scores system outside the Baltic region.
- Liaise with Social, Economic and Governance Expert Groups to scope sea trout issues.
- Apply for EU funding to develop the training network of PhDs.

Notes from WGDIAD

The group welcomed the presentation and briefly discussed the plans for 2022.

3 New Expert Groups

No new Expert Groups were formally proposed for 2022

3.1 Proposed/approved for 2022

The 2nd NASCO Workshop for North Atlantic Salmon At-Sea Mortality (WKSALMON2) has been approved for 2022. The ToRs are currently being discussed between ICES and NASCO.

Scoping meeting(s) for the WGNAS benchmark, currently scheduled for 2023, are also proposed for the 2nd half of 2022.

The chair of WGEEL wanted to bring the potential WKFIA (Workshop on Eel Advice) to the attention of the group. This workshop would to produce a roadmap for the next five years working towards a benchmark assessment for eel.

Also discussed was a possible future EG on data quality assurance and/or quality control for diadromous fish assessment groups. The group agreed on the usefulness and need of such an EG.

4 Theme Sessions and Symposia

4.1 Theme sessions

The proposal for a Theme Session for the 2023 ASC as discussed at the 2020 WGDIAD meeting is still considered. This proposal focuses on species which inhabit or move through transition zones, either permanently or as a gateway between freshwater bodies and the sea and how these species can be affected (disrupted) by non-native species (be they introduced, exotic, invasive or alien). The focal point of the theme session would be on the disruptions to and changes in previously commercially viable fisheries in these transition zones. This would not be limited to anadromous or diadromous fisheries but rather any fishery or cultivation (arthropods, algae etc.) affected by the presence of non-native species. The theme session would be split into two subgroups with a morning session on algae and invertebrates and an afternoon session on vertebrates. This proposal will be submitted before the summer 2022 deadline.

Additional comments in relation to this proposal at the 2022 WGDIAD meeting were made on the potential use of eDNA to track invasive/non-native species in freshwater/brackish water bodies, as it currently done for Alosids in Canada and with Pink salmon in the River Teno in Finland.

4.2 Symposia

The Atlantic/Pacific salmon Round Table meeting showed a considerable amount of interest in a Pink salmon meeting/workshop to discuss range expansion of this species in both the Atlantic and Pacific Oceans. WGDIAD and the NPAFC are currently discussing a format for this. The most likely venue for this will be before the IYS closing symposium in October 2022 in Vancouver Canada, but this needs to be confirmed.

Other potential topics for future symposia were:

- Climate Change
- Reintroductions and non-natives (e.g. beavers, pink salmon)
- Assessment of habitat quantity and quality (e.g. salmon, eel, sea trout)
- Influences of habitat - past, present and future (e.g. eel)
- Challenges of using juvenile data to assess and manage adults (e.g. salmon, sea trout, eel)
- eDNA
- Ecosystem components which are modifying the species abundance and population dynamics

5 International Year of the Salmon (IYS)

A closing symposium of the IYS will be held in October 2022 in Vancouver, Canada.

6 Proposals for Publications

There were no specific proposals for publications.

7 Update from the Intersessional Sub Group Diadromous fish (ISSG Diad) of the Regional Coordination Groups (RCG)

The Intersessional Sub Group Diadromous fish (ISSG Diad) overall task is to progress development of the regional work/sampling plans for data collection for diadromous species/stocks (Atlantic salmon in the Atlantic and Baltic, sea trout in the Baltic, European eel throughout its natural range) and quality assurance of those data.

The current EU Data Collection Framework (DCF) will finish at the end of 2021. It will be replaced by the Data Collection Multi-Annual Programme (DC-MAP) in 2022:

DC-MAP Data collection methods and data requirements

Biological data on exploited biological resources caught by Union commercial and recreational fisheries

2.1. As regards commercial fisheries:

In addition, the following data shall be collected on eel, salmon, and sea trout (Baltic Sea only) caught during the freshwater part of their lifecycle, however such fisheries are undertaken:

i. Stock-related variables selected by Members States at a regional level based on end-user needs,
ii. annual catch quantities for salmon and sea trout,
iii. annual catch quantities by life stage for eel

2.2. As regards recreational fisheries, Member States shall implement statistically robust multispecies sampling schemes that enable catch quantities to be estimated for stocks agreed at regional level, in accordance with the relevant end-user needs.

2.3. In addition:

a) for salmon and sea trout, data shall be collected on the abundance of smolt and parr and the number of ascending individuals in rivers.

The designation of bodies of water, including rivers, the selection of stock-related variables to be collected and monitored, and the sampling frequency for salmon, sea trout and eel shall be defined and coordinated at regional level, depending on end-user needs. Where no regional coordination exists, Member States shall establish national sampling schemes based on end-user needs.

The current priorities for ISSG Diad are adapting data collection to changing and improving assessment models and data need of end-user groups, address Quality Assurance of data, and help develop and implement regional work plans for data collection, in order to gain comparable and homogenous (in terms of quality) data bases for end-users. The latter is being undertaken by the FISHN'CO (Strengthening EU-MAP data collection by developing Regional Work Plans for NANS&EA, Baltic and Large Pelagics RCG and PGECON) research consortium. In relation to diadromous fish FISHN'CO's core tasks are regional harmonisation of catch and effort data, progress index river designation, and address QA in electrofishing data.

8 Coordination of Science on Diadromous Species

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

Dennis Ensing attended the 2021 Fisheries Resources Steering Group (FRSG) meeting on 8 November 2021 on behalf of WGDIAD.

8.2 Atlantic – Pacific Diadromous fish science link

After discussions in 2019 and 2020 there was consensus that WGDIAD should reach out to diadromous fish scientists beyond the Atlantic basin and establish some form of collaboration. This idea was worked on intersessionally and cumulated in Mark Saunders of the North Pacific Anadromous Fish Commission (NPAFC) joining the 2020 meeting to discuss possible avenues for collaboration, not just with the NPAFC but with the wider scientific community working on diadromous fish in the Pacific. The group agreed that WGDIAD, ICES, and Mark Saunders should work on a proposal for this collaboration intersessionally. One of the first results of this collaboration was a joined WGDIAD/NPAFC event during the 2021 WGDIAD meeting, the Pacific/Atlantic salmon Round Table.

8.3 Pacific/Atlantic salmon Round Table

The online meeting was attended by 68 salmon scientists working in both the Atlantic and Pacific Ocean basins. The format of the meeting was such that six topics were introduced by experts, before opening the floor for discussion. The aim was not to focus on the introductions, which were kept short for that purpose, but on the discussion of the six topics. An official summary of the meeting will be available in early 2022. Below is given a short summary of the meeting for the benefit of the WGDIAD members.

Status of Pacific and Atlantic salmon

Presentations by Laurie Weitkamp (Pacific) and Hugo Maxwell (Atlantic)

Salmon populations in the Pacific and Atlantic have experienced declines over the past three decades. Atlantic populations have seen consistent declining trends since the 1980s, while Pacific salmon populations have seen greater variability between populations and between years. In both the North Atlantic and North Pacific, there is evidence of some more northern populations experiencing stronger returns in recent years than their southern counterparts. Increasing ocean and atmospheric temperatures have been and are expected to continue in both basins, with several marine major heatwaves in the North Pacific over the past decade that have had major ecosystem impacts. Other climate change related issues present in both basins, include reduced precipitation and higher temperatures that have resulted in altered freshwater flow regimes salmon-bearing streams.

Due to limited time during the Roundtable, there was no active discussion on areas of collaboration related to the status of Pacific and Atlantic salmon. However, given the range of threats faced by salmon populations in both basins, future collaboration on efforts to address these threats would be of great benefit to both basins. Additionally, coordinating efforts between

basins on the reporting of the status of salmon could help improve inter-basin collaboration and communication. The 2022 IYS Symposium: 'Salmon in a Rapidly Changing World: Synthesis of the International Year of the Salmon and a Roadmap to 2030' has been identified as a suitable forum to present a joint Atlantic-Pacific status of salmon report.

Life history modelling

Presentations by Brian Wells (Pacific), Catherine Michielsens (Pacific), and Etienne Rivot (Atlantic)

Life history modelling efforts in both the North Pacific and North Atlantic basins have been centred around testing hypothesis related to the mechanisms and drivers of salmon productivity considering recent decreases in marine survival in both basins. The utility of integrated life history modelling is evidenced by improvements to the accuracy of forecasting model outputs for Fraser River (British Columbia) sockeye after record-low returns in the late 2000's. The integration of information from all life history stages into the selection of models enabled more accurate forecasting through the 2010s.

In the Atlantic, stage-based population models have been developed that track cohort dynamics from eggs-to-eggs with the aim of assessing variations in first year marine survival and the proportion of fish maturing as one-sea-winter fish. These models have revealed evidence of basin-scale synchronicity in marine mortality rates which have been partially explained by variations in sea surface temperature and primary productivity. Modelling efforts focused on Californian salmon populations have identified marine predation, temperature, and freshwater flow as key factors influencing salmon survival, with marine predation having the greatest effect. Modellers in both basins noted the importance of viewing salmon within the broader scope of the entire marine ecosystem with regards to modelling and the need for collaboration with other scientific communities outside of salmon, such as oceanography, fisheries, and ecology.

Participants noted the similarities in Atlantic and Pacific salmon trends over the past half-century, particularly the declines in productivity in the 1990s, and there was shared interest among scientists from both basins in further investigating this. Historical scale archives were identified as a data source that could inform these efforts. The similarities between steelhead trout and Atlantic salmon, and the potential benefits of comparing historical trends between these were also highlighted as potential areas of future cross-basin collaboration.

Range redistribution and interspecific competition

Presentations by Karen Dunmall (Pacific), Jim Irvine (Pacific), and Panu Orell (Atlantic) and Jaakko Erkinaro (Atlantic)

A changing climate and the introduction of non-native species have resulted in major changes in the distributions and ranges of salmon species in both basins. Throughout the Canadian Arctic, Atlantic salmon and Pacific salmon species have been caught more frequently and in greater numbers by communities in the last decade than has been historically recorded, with variability in the number of species and total number of fish caught between years. After being introduced into the Russian Arctic in the 1950s, pink salmon populations in the northeast Atlantic have seen major increases in abundance and southward range shifts, particularly in the past five years. The North Pacific has also experienced major increases in pink salmon abundances over the past half-century. Several studies have provided evidence to suggest that pink salmon in the North Pacific can cause trophic cascades and affect the productivity of other salmon species. The adaptability of pink salmon and the predicted benefits to pink salmon populations from climate change suggests that the observed competition impacts could be exacerbated. The influence of competition between Atlantic salmon and non-salmon species, as well as pink salmon and Atlantic salmon

were identified as areas of potential future study that could help better understand variations in salmon productivity in the marine environment.

It was highlighted that concern shared by communities throughout the Canadian Arctic revolved around the origins of Pacific salmon in the Arctic and the interactions between salmon and Arctic fishes in the freshwater and marine environments. Several key knowledge gaps exist related to these areas that could benefit from inter-basin collaboration:

- The environmental drivers influencing the northward range shifts
- The origins of Pacific salmon in the Arctic, whether they are coming from Arctic, Pacific, or Atlantic populations
- The ecology of cold-adapted populations of Atlantic salmon
- A comprehensive genetic baseline of salmon from across the Arctic
- The minimum temperature tolerances and winter ecology of salmon in freshwater
- Salmon habitat use in the Arctic marine environment
- Current interactions between salmon and Arctic species

Atlantic participants noted that limited research had been undertaken on the origins of pink salmon in the Northeast Atlantic and that further work with genetic stock identification techniques, as has been done in the North Pacific, would be a useful avenue of future research to better understand the origins of pink salmon throughout the North Atlantic and Arctic. The potential for the Northeast Atlantic being prey-limited was raised, with past genomics work in the Pacific suggesting that in prey-limited areas, salmon show signs of immunosuppression and increased infection agent burdens. Another issue associated with pink salmon range expansions raised that could benefit from inter-basin collaboration was the potential for the introduction of novel pathogens to areas where they do not normally occur. It was noted that the Alaska Department of Fish and Game has developed a panel of genetic markers that can help identify the origins of pink salmon caught in the Canadian Arctic. The idea of a joint Pacific-Atlantic pink salmon workshop was also raised with positive responses from Atlantic and Pacific participants.

Techniques and technologies

Presentations by Dion Oxman (Pacific), Christoph Deeg (Pacific), and Dennis Ensing (Atlantic)

In the North Atlantic, there are a large number of acoustic telemetry projects that aim to improve knowledge of freshwater, estuarine, and in-shore salmon mortality and migration. Efforts to expand the use of acoustic telemetry to better understand salmon migration and mortality in offshore areas have been in development in recent years, specifically utilizing RAFOS Ocean Acoustic Monitoring (ROAM) technology. In the North Pacific, the study of incrementally grown structures, such as otoliths and opercula, has been used to produce age-specific reconstructions of salmon life histories, including responses to temperature, trophic ecology and movements, as well as stock structures. By extracting information on both hormones and isotopes from these structures, reconstructed life histories of the physiological responses of salmon to physical parameters such as temperature have also been created. It was also noted that the large historical collections of hard structures held by many governments and institutions hold invaluable information about the historical responses of salmon to changes in their environments, and these require greater research attention. During the 2019 and 2020 IYS Gulf of Alaska High Seas Expeditions, genomic technologies such as the Fluidigm BioMark, Fit-Chip, and Nanopore minION sequencing, were successfully utilized to extract pathogen diversity, infectious burden, at-sea genetic stock ID, and gene expression from salmon tissue samples. COI metabarcoding was also utilised to analyze Environmental DNA (eDNA) from water samples which provided information about salmon, prey, and cryptic predator presence/absence.

Current collaboration between Pacific and Atlantic scientist is occurring through the application of Fit-Chip genetic technology to historical post-smolt samples from Norway to extract information on the factors affecting marine survival, particularly for stocks of conservation concern. Interest was also expressed from both Pacific and Atlantic attendees in further collaboration in the area of genomics and the potential uses of existing inventories of bony structures including the use of hormones from incrementally grown structures to reconstruct salmon life histories. It was noted that the extraction of hormones from scales is in the early stages of development in the Pacific as it was also noted that scales are widely available structure present in certain Atlantic salmon related archives.

High seas surveys

Presentations by Aidan Schubert (Pacific) and Kjell Utne Rong (Atlantic)

In the North Atlantic, high seas surveys have been conducted regularly over the past three decades in both May and July/August, with the primary objective of better understanding species such as herring and mackerel, however, they have also collected valuable data on Atlantic and pink salmon. Results from these surveys have helped to improve understanding of the early marine distributions of and prey availability for Atlantic salmon, as well as the distribution and life histories of pink salmon in the Northeast Atlantic. In the North Pacific, a series of international winter high seas expeditions took place in the Gulf of Alaska in 2019 and 2020, as part of IYS activities, to test the key hypothesis that factors affecting salmon return abundance mostly occur by the end of the first ocean winter. The IYS 2022 Pan-Pacific Winter High Seas Expedition will involve up to five research vessels and scientists from up to five countries and will set out that will utilize emerging technologies such as eDNA and gliders to build on the work of the 2019 and 2020 Gulf of Alaska Expeditions.

Due to limited time during the Roundtable, there was no active discussion on areas of collaboration related to high seas surveys. However, given the similarities in the scale and techniques used in both Atlantic and Pacific high seas expeditions, and their importance for helping to improve knowledge of the marine phase of the salmon lifecycle, sharing of knowledge about high seas surveys between basins has great potential to be beneficial.

Data mobilisation

Presentations by Brett Johnson (Pacific) and Colin Bull (Atlantic)

Data mobilisation efforts in both the Pacific and Atlantic basins have strived to ensure data adheres to the FAIR data principles (Findable, Accessible, Interoperable, and Reusable). Data mobilisation efforts in the North Atlantic have focused on placing data in a user-friendly framework for scientists to use to answer questions related to salmon mortality. A major project that this data mobilisation work is enabling is lifecycle modelling for southern European Atlantic salmon, utilising freshwater, estuarine, and marine ecological, physical, and biological data. In the North Pacific, there have been significant efforts to mobilise data from the 2019 and 2020 IYS Winter High Seas Expeditions, ensuring that the data are organised under the United Nation's Global Ocean Observing System (GOOS) and published to the Environmental Research Division's Data Access Program (ERDDAP) and the Ocean Biodiversity Observing Information System (OBIS).

A major challenge to data mobilisation that was expressed from both the Atlantic and Pacific speakers was the lack of willingness of data holders to share data due to the multitude of stakeholders and agencies involved in data collection and funding, with various expectations around data publishing, and insufficient incentive to publish data. Collaboration between Pacific and Atlantic basins exists around salmon data mobilization, with regular discussions on data

mobilisation challenges and successes occurring, however, there remains room for this shared work to continue and grow. The importance of separate data mobilisation efforts connecting to each other was highlighted by participants as well as the need to ensure that data mobilisation efforts move beyond simple inventories of project titles and information, and work toward better connecting scientists working on similar issues. The idea of coordinated data mobilisation efforts between both basins as a key element of the NPAFC-ICES connection going forward as well as the United Nations Decade of Ocean Science was highlighted, particularly the utilisation of graph databases.

The feedback received about the Round Table was very positive. There was a lot of enthusiasm among the attendees, specifically on the topic of range expansion of Pink salmon. This has resulted in the plans to hold a Pink salmon workshop in 2022 as an event under the WGDIAD/NPAFC collaborative umbrella.

8.4 Living Planet Index (LPI) For Migratory Freshwater Fish Report

Louise McRae from the Institute of Zoology gave a presentation to the group on the Living Planet Index (LPI) For Migratory Freshwater Fish Report (Deinet *et al.,* 2020).

Migratory freshwater fish occur around the world and travel between critical habitats to complete their life cycle. They are disproportionately threatened compared to other fish groups but global trends in abundance, regional differences and drivers of patterns have not yet been comprehensively described. Using abundance information from the Living Planet Database, we found widespread declines between 1970 and 2016 in tropical and temperate areas and across all regions, all migration categories and all populations. Globally, migratory freshwater fish have declined by an average of 76%. Average declines have been more pronounced in Europe (-93%) and Latin America & Caribbean (-84%), and least in North America (-28%). The percentage of species represented was highest in the two temperate regions of Europe and North America (almost 50%). For the continents of Africa, Asia, Oceania, and South America, data was highly deficient, and we advise against making conclusions on the status of migratory freshwater fish in these areas. Potamodromous fish, have declined more than fish migrating between fresh and salt water on average (-83% vs -73%). Populations that are known to be affected by threats anywhere along their migration routes show an average decline of 94% while those not threatened at the population level have increased on average. Habitat degradation, alteration, and loss accounted for around a half of threats to migratory fish, while overexploitation accounted for around one-third. Protected, regulated and exploited populations decreased less than unmanaged ones, with the most often recorded actions being related to fisheries regulations, including fishing restrictions, no-take zones, fisheries closures, bycatch reductions and stocking (these were most common in North America and Europe). Recorded reasons for observed increases tended to be mostly unknown or undescribed, especially in tropical regions. This information is needed to assemble a more complete picture to assess how declines in migratory freshwater fishes could be reduced or reversed. Our findings confirm that migratory freshwater fish may be more threatened throughout their range than previously documented.

Notes from WGDIAD

The group was very supportive of the efforts and proposed a collaboration in the future as the ICES diadromous fish EGs can provide data and expertise to such assessments in the future.

8.5 Unlocking the Severn Project

Randolph Velterop from Natural England gave an update on the Unlocking the Severn Project. This project aims to restore the Shad (*Alosa sp.*) populations on the River Severn in England by improving connectivity, engaging the local community, and encouraging citizen science projects in support of the project.

9 Election of officers

Hugo Maxwell (Ireland) was re-elected as co-chair for the period 2022–2024.

10 Any other business

There was no other business.

11 Next meeting

The next meeting will be held during the ICES ASC 2022, 19–22 September 2022 at the Aviva Stadium, Dublin, Ireland.

12 References

Deinet, S., Scott-Gatty, K., Rotton, H., Twardek, W. M., Marconi, V., McRae, L., Baumgartner, L. J., Brink, K., Claussen, J. E., Cooke, S. J., Darwall, W., Eriksson, B. K., Garcia de Leaniz, C., Hogan, Z., Royte, J., Silva, L. G. M., Thieme, M. L., Tickner, D., Waldman, J., Wanningen, H., Weyl, O. L. F. (2020) The Living Planet Index (LPI) for migratory freshwater fish - Technical Report. World Fish Migration Foundation, The Netherlands.

Annex 1: List of participants

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Annex 2: Agenda for WGDIAD 2021

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

Chair: Dennis Ensing & Hugo Maxwell

30th August – 2nd September 2021 14.00–18.00 (CET) (Wednesday September 1st 15.00–18.00 CET), by WebEx

Agenda:

Monday August 30th

14.00 – 14.15 Welcome and Introductions

14.15 – 14.30 Adoption of the Agenda and Appointment of a Rapporteur/Rapporteurs

14.30 – 14.40 WGDIAD ToRs for 2021 to 2022

14.40 – 15.00 Intersessional Activities 2020-2021

15.00 – 15.30 Presentation and discussion WKSALMON/WKSALMON2 – (2nd) Workshop for North Atlantic Salmon At-Sea Mortality: Dennis Ensing.

15.30 – 16.00 Break

16.00 – 17.00 Update from the EU DCF Regional Coordination Groups Intersessional Group Diadromous fish (ISSG Diad): Marko Freese/Tapani Pakarinen

17.00 – 18.00 Presentation and discussion WKSalModel - Workshop for Salmon Life Cycle Modelling: Dennis Ensing

Tuesday August 31st

14.00 – 14.20 Introductions and photo of group

14.20 – 14.30 Agenda and Appointment of a Rapporteur

14.30 – 15.30 Presentation and discussion WGNAS – Working Group on North Atlantic Salmon: Dennis Ensing

15.30 – 16.00 ASC Theme Session proposals for ASC 2022 and symposia: Hugo Maxwell

16.00 – 16.20 Break

16.20 --16.40 Proposals for new Expert Groups

16.40 – 17.30 Presentation and discussion WGBAST – Working Group on Baltic Salmon and Trout: Martin Kesler

17.30 – 18.00 Links with WGBAST

Wednesday September 1st

15.00 – 18.00 ICES/NPAFC Atlantic/Pacific salmon Round table

Thursday September 2nd

14:00 – 14:30 45 Unlocking the Severn Project – Natural England: Randolph Velterop

14.30 – 15.00 Presentation and discussion WGEEL – EIFAAC/ICES/GFCM Joint Working Group on Eel: Jan-Dag Pohlmann.

15.00 – 15.30 Introduction to the living planet index and discussion IOZ- Robin Freeman (Institute of Zoology, UK)

15.30 – 16.00 Break

16.00 – 16.45 Presentation and discussion WGTRUTTA - Working Group to develop and test assessment methods for Sea trout populations (anadromous *Salmo trutta*): Johan Höjesjö/Alan Walker

16.45 – 17.45 Synthesis Round Table

17.45 – 18.00 Election for new co-chair / Any Other Business/ Next meeting

18.00 Close Meeting

Annex 3: Recommendations

There were no WGDIAD recommendations for 2021.