ICES WORKING GROUP ON MARITIME SYSTEMS (WGMARS)

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ICES International Council for the Exploration of the Sea
CIEM Conseil International pour l'Exploration de la Mer

Contents

i Executive summary

The Working Group on Maritime Systems (WGMARS) is a forum for interdisciplinary perspectives on ecosystem science, advice, and governance. It engages with maritime stakeholders from across the North Atlantic to take into consideration and better understand their perspectives.

From 2020-2022 WGMARS is focused on methodological, operational, contextual, and science management aspects enabling ecosystem-based maritime management/governance. Topics addressed in this report include the ways that behavioural economics could inform and could be used for an enhanced understanding of fisheries management, the development and use of integrated ecosystem assessments (IEA) in ICES, the types and extent of connectivity among ICES expert groups based on Social Network Analysis (SNA) and the ways in which (IEA), Ecosystem Based Management (EBM), and MSP (Marine Spatial Planning) are implemented in different European Union (EU) member states, the EU, and the United States.

Plans for a systematic literature review of the relevance of behavioural economics in fisheries management were developed. Related work on nudging in fisheries management and compliance with marine mammal protection regulations was summarized.

Interviews with ten ICES regional IEA expert groups have been completed. Preliminary analyses have identified commonalities and differences among groups, in relation to topics such as contributions to ICES advice, the role of social scientists, the maturity of the IEA they conduct, resource needs, the role of stakeholders and the balance between descriptive and quantitative science.

SNA, using a database of 2015-2019 attendees at ICES expert groups, is being used to quantify the centrality of a node expert group in relation to other expert groups in any given year. Four measures of centrality have been adopted: degree centrality, betweenness centrality, closeness centrality, and eigenvector centrality. Results of the analysis will reveal the strengths and types of connections among ICES expert groups, which are expected to influence the effectiveness and impact of ICES ecosystem and sustainability science.

With regard to the implementation of IEA, WGMARS reviewed the development of the national IEA program in the United States, based on reported talks from relevant scientists and managers. At future meetings, the outcomes of this review will be compared those for IEA implementation in other countries and regions.

ii Expert group information

Expert group name	Working Group on Maritime Systems (WGMARS)
Expert group cycle	Multi-annual fixed term
Year cycle started	2020
Reporting year in cycle	1/3
Chair(s)	Patricia M. Clay, US
	Johanna Ferretti, Germany
Meeting venue(s) and dates	20-24 April 2020, WebEx and by correspondence (18 participants)

1 Terms of Reference Defined

ToR	Description	Background	Science plan topics addressed	Duration	Expected deliverables
A	Analyse how the use of behavioural economics can support IEA/EBM implementation	Policy evaluation in IEA requires insight into human behaviour in order to (1) predict how users respond to policy interventions, and (2) how stakeholders judge trade-offs between conflicting objectives.	6.3, 7.4, 7.5	Years 1,2,3	Peer-reviewed paper on behavioural economics for policy evaluation
B	Review and provide guidelines for conceptual modelling to assist Regional Seas WGs	Conceptual modelling, including through the use of, for instance, Mental Modeller or Bow-Tie Analysis, can aid scientists from different fields, as well as scientists and stakeholders, to facilitate improvements to their IEA activities.	5.3, 6.2, 7.5	Year 1, 2, or 3	At least one workshop with one or more ICES Regional Seas or other IEA-related WGs
C	Evaluate the current development and use of ICES IEAs in support of management and advice	ICES has prioritized the development and use of IEAs, e.g. in the Regional Seas WGs, as a tool for understanding trade-offs in fisheries and maritime policies.	1.9, 3.2, 6.1	Years 1,2	Peer-reviewed paper on the current status of IEAs in the regional seas WGs
D	Apply Social Network Analysis (SNA) as a tool to assess ICES network connectivity and preparedness to address IEAs and the ICES Science Plan	ICES is dedicated to supporting EBM in fisheries and maritime governance. The SNA will analyse interactions of ICES EGs and the extent to which the organizational set up is a good "fit" for facilitating science for EBM.	6.3, 7.4, 7.5	Years 1,2,3	Peer-reviewed paper on the SNA of ICES
E	Analyse and compare the implementation and linkages of IEA/EBM/MSP and fisheries in the EU, individual European member states, and the US	ICES supports the use of EBM and IEAs, while many EU states support MSP. There is a need to connect science done for both purposes and IEA (supported by ICES) is a tool that could be used with either EBM or MSP.	7.4, 6.1, 6.6	Years 1,2	ICES Report

2 List of Outcomes and Achievements of the WG in 2020 (Year 1 of 3)

ToR A Analyse how the use of behavioural economics can support IEA/EBM implementation

Behavioural economics is a branch of economics that studies the effects of psychological, cognitive, emotional, cultural and social factors on the decision-making (see Thaler & Sunstein 2010). The approach has gained much ground in recent years in everything from increasing the rate of organ donation, to increasing tax compliance, decreasing litter rates, and increasing road safety, to name but a few. As a low cost, potentially high reward approach, behavioural economics may provide the tools to tackle some of the complex problems currently facing marine fisheries (e.g. Abbot and Wilen 2009, Mackay *et al.* 2018, Battista *et al.* 2018, Bisack and Clay 2020).

A number of meetings to advance the WGMARS BE paper, both virtual and in-person, has been conducted since the 27-31 May 2019 annual meeting that closed our previous ToRs. The meetings were used to discuss the paper outline and next steps for the group and the intern (see below) and to identify and structure possible case studies.

The BE sub-group is currently looking at finding an intern to conduct a systematic literature review of behavioural economics in fisheries management, and perhaps interview experts on real world cases and to contribute to a written report on relevance of behavioural economics for fisheries management. This report will feed into the WGMARS BE paper.

We have also developed a news story on the BE sub-group, to be featured on the WGMARS home page, and sent a tweet on the sub-group to advertise its activities.

Additional BE activities have also occurred since we began the new ToRs period. A behavioural economics presentation by multiple WGMARS members and a colleague was submitted to the 2020 World Fisheries Congress (WFC) (11-15 Oct 2020, Adelaide, Australia). It is now unclear if the WFC will take place. The abstract is here below:

Sarah B. M. Kraak, Andries Richter, Rolf Groeneveld, Dorothy J. Dankel, Ingrid van Putten, Sebastian Uhlmann, Katell G. Hamon, Marloes Kraan, Debbi Pedreschi, Johanna Ferretti. *To nudge or not to nudge; is nudging in fisheries management necessarily libertarian paternalism?* Not complying with fisheries' regulations is a problem inhibiting the sustainable use of marine ecosystems. Control and enforcement are costly and are frequently not sufficiently effective. Moreover, top-down control, insufficient sanctioning mechanizms, and lack of trust in the governance system as well as in other participants in the fishery can undermine intrinsic motivations to comply. Apart from enhanced marine governance, can positive reinforcement and indirect suggestion -- so-called nudging, help change compliance behaviour? Or, does it further erode trust? The ethics of nudging is debated in various fora. Opponents claim that nudging represents libertarian paternalism where the nudgers decide top-down what is "good for" the nudgees. We distinguish cases in fisheries management where the desired behaviour is not (only) "good for" the nudgee but for society at large: the sustainability of marine resources (or another common good) is at stake. Moreover, what if "good behaviour" could be co-decided bottom-up by the nudgees rather than top-down by the nudgers only. Perhaps these distinctions legitimize nudging. The purpose of this presentation is to bring the nudging debate into fisheries.

In addition, a behavioural economics presentation on one of the case studies in the behavioural economics spreadsheet (Bisack and Clay 2020) was submitted by a member of the WGMARS BE

sub-group and a colleague to the 2020 ICES ASC. The ASC has been cancelled, but we may present in 2021. That abstract is here below:

Patricia M. Clay and Kathryn D. Bisack. *Compliance with marine mammal protection: Focus groups reveal factors in commercial fishermen's decisions.* In researching non-compliance with use of an acoustical device (a pinger), required under the Marine Mammal Protection Act (MMPA) to protect harbor porpoise (*Phocoena phocoena*) in the Northeast US, focus group research provided insight on facets of non-compliance not previously considered. This method of group interview can reveal individuals' knowledge and perceptions of the legitimacy of a problem, process and solution along with social (including legitimacy) and economic factors, and cultural norms that can influence compliance or other decisions. In addition, each participant filled out a short survey on topics we already expected to be of interest. We investigate how these factors from the focus group discussion and the survey influence a fisher's decision to comply with marine mammal regulations. Prior to the focus groups we expected participants to either fully comply or not comply at all with pinger requirements. By using multi-research methods, we found that there was a third group that included fishermen that mostly complied but eliminated one mandatory pinger for safety reasons. Using harbor porpoise as a case study, we provide insight on approaches to improve compliance, a key component of a successful management plan designed to reduce marine mammal bycatch in commercial fisheries.

ToR B Review and provide guidelines for conceptual modelling to assist Regional Seas WGs

Led by Debbi Pedreschi, several WGMARS members are applying for a EuroMarine grant to hold a methods workshop focused on conceptual modelling for IEA. The objective is to develop guidance for ICES IEA groups and other interested users on applying conceptual modelling as a scoping method and method for social learning through knowledge integration, e.g. of scientists with different backgrounds and/or stakeholders from various maritime sectors. Also, several of the NOAA speakers (see ToR E, below) discussed the use of conceptual modelling with stakeholders as part of the NOAA IEA process. This provided additional input for our planning in relation to this ToR.

ToR C Evaluate the current development and use of ICES IEAs in support of management and advice

The peer-reviewed paper on the status of IEAs in the regional seas WGs is in process. After making progress on the paper at our 2019 annual meeting in late May, we held two webex meetings over the summer to continue work on this manuscript, on 24 July 2019 and 27 August 2019.

A presentation was made at the 2019 ASC: Patricia M. Clay, Johanna Ferretti, Christine Röckmann,; Jennifer Bailey, Dorothy Dankel, Geret DePiper, Ana Rita Fraga, Sarah Gaichas, Susan Gardner, David Goldsborough, Leyre Goti, Rolf Groeneveld, Katell Hamon, Andrew Kenny, Marloes Kraan, Sebastian Linke, Sean Lucey, Kåre Nolde Nielsen, Isa Olalekan Elegbede, Gerjan Piet, Patricia Pinto da Silva, Marina Santurtún, Jörn Schmidt. Integrated Ecosystem Assessment Implementation in the ICES Regional Seas Working Groups: Conceptualizations, Practice, and Progress. 2019 ICES Annual Science Conference, Göteburg, Sweden.

The following preliminary results were presented:

Commonalities across IEA groups, based primarily on 2018 interviews

- Except for WGNARS and WGICA, each with caveats, **groups are not directly asked for information that would feed into official advice** or decisions, at ICES, national, or EU levels
- Most **groups don't feel connected to advice processes**. Their **role is seen as solely developing the science** and methods behind EBM and IEA.
- **Few groups have social scientists** and many aren't clear how they would bring added value or how to work with them
- **No group feels it has truly done a full IEA** and some consider that they are primarily still doing ITA (Integrated Trend Analysis), though all aspire to IEA
- **To conduct regular IEAs, groups feel they would need more resources from ICES** – similar to the support received by stock assessment groups

Differences:

- Some have **regular coordination with other WGs or other groups**, while others do not
- Some **involve stakeholders** while others do not, and the **presumed role of stakeholders varies**. In some cases, stakeholders are seen as providing **guidance on what areas of research** are important, while in other cases stakeholders are seen as a **source of data for scientific research**
- Most are heavily involved in **mathematical modelling**, while one distrusts models and prefers pure description

Highlights from the presentation were also presented at the IEASG meeting at the 2019 ASC and discussed fruitfully with all those in attendance.

A coding session for the transcripts of regional seas WGs interviews occurred via webex on 27 March 2020. We then used the April 2020 annual meeting to begin the second round of coding (to allow for inter-rater reliability testing) and the formal analysis of the interviews for the Results section. This process will continue through 21 May. Time was also put aside at the April 2020 annual meeting to revise existing draft sections (Introduction, Background, and Methods); final drafts of these sections will also be completed by 21 May. At that point the co-chairs will review and revise the full draft of these major sections of the paper and send the compiled sections back to the group for review. A 4-hour joint discussion and editing session will take place on 28 May to finalize the full draft, after which the co-chairs will review it one last time for submission to the *ICES Journal of Marine Science*.

In addition, Patricia Clay and Leyre Goti took part remotely in the ICES Workshop on Challenges, Opportunities, Needs and Successes for including human dimensions in IEAs (WKCONSERVE) that took place in Copenhagen from 8-10 October 2019.

ToR D Apply Social Network Analysis as a tool to assess ICES network connectivity and preparedness to address IEAs and the ICES Science Plan

The underlying social theory behind our SNA is that ecosystem and sustainability science depends on strong connections among ICES EGs. Although there are many ways that scientists can passively integrate data, models, disciplines and scientific theories (e.g. through reading papers and individual scholarly work), sociologists of science pay close attention to the social connections of scientists and groups. SNA allows for a statistical analysis of how people are connected, and for purposes of ICES, we concern ourselves with how "well-connected" the ICES network is

through individuals whose shared participation in different Expert Groups and Workshops "connects" the science.

In January 2019, a sub-group of WGMARS met for a 3-day workshop at the Stockholm Resilience Centre to re-join Örjan Bodin to create a reliable database with updated data from the ICES Secretariat. Follow-up webexes were held on 2 March 2020 and 22 April 2020. The preliminary results were then presented in April 2020 during the WGMARS annual meeting. An additional webex is planned for 27 May.

We are also planning a news story on the SNA sub-group, to be featured on the WGMARS home page. A sneak peek on WGMARS' SNA analyses was tweeted on 24 April to advertise its activities.

Four simple measures of the ICES networks of expert groups and workshops for the five-year period of 2015–2019 were examined: degree centrality, betweenness centrality, closeness centrality, and eigenvector centrality. This database will be the foundation of a peer-reviewed paper, currently in progress, by the SNA sub-team of WGMARS. In addition to the overall examination of connections across ICES EGs/WKs, the manuscript in preparation will delve deeper into the formation of the Integrated Ecosystem Assessment (IEA) Regional Seas groups, which allows WGMARS to connect SNA to IEA, two Terms of Reference for the period of 2020–2022. We will present the SNA paper at the 2021 ICES Annual Science Conference in Copenhagen.

ToR E Analyse and compare the implementation and linkages of IEA/EBM/MSP and fisheries in the EU, individual European member states, and the US

Integrated Ecosystem Assessment (IEA), Ecosystem-Based Management (EBM), and Marine Spatial Planning (MSP) are all used in various national governments and the European Union for improving fisheries management. During the 2019 WGMARS annual meeting in San Sebastián, Spain at the end of our previous ToRs period, the question of how IEAs fit in contemporary governance and management systems was addressed through presentations by WGMARS members on IEA and governance in the their home countries, as well as at EU level. At the 2020 annual meeting by webex that began Year 1 of the current ToRs period, WGMARS delved more deeply into how NOAA has developed its national IEA Program. Through talks by Stephanie Oakes (NOAA IEA Program Manager), Mark Monaco (Chair, NOAA IEA Steering Committee), Chris Kelble (Co-Lead, NOAA IEA Gulf of Mexico Program/former Chair, NOAA IEA Steering Committee), Ellen Spooner (NOAA IEA Communications Specialist), and Stephen Kasperski (Lead, NOAA IEA Human Dimensions Working Group/member, NOAA IEA Steering Committee), we learned the history and current status of NOAA's IEA Program and some of its plans for future development.

Stephanie Oakes, who coordinates IEA efforts across NOAA, stressed the importance of the IEA program for NOAA and its link to NOAA's commitment to advance the use of Ecosystem-Based Management for all marine activities. NOAA first began examining this approach in 2005 and celebrated 10 years of developing and applying IEAs in 2019. The development of IEAs is an effort that includes all of NOAA's research-based line offices, bringing together the many scientific disciplines of the agency. The collection of existing data and creation of condition reports and ecosystem status reports are important to the process. NOAA stresses that for the agency, "the ecosystem" includes humans, and it is an agency goal to incorporate socio-economic dimensions into its work. The NOAA approach in general relies heavily on stakeholder participation and partnerships among scientists, stakeholders, managers and government for co-development

of knowledge, data collection, problem identification, and establishing both concerns and priorities; the "Loop" found in Levin *et al.* (2009), with its emphasis on the scoping process, figures heavily in the conceptualization of the IEA process. Mark Monaco who is situated within NOAA's National Ocean Service, focused on the relationship between IEAs and the National Marine Sanctuaries Program. He again emphasized the importance of stakeholder participation early in the process and the importance of scale in understanding events and trends within Sanctuaries and beyond. Chris Kelble, of NOAA's Office of Oceanic and Atmospheric Research, focused on IEA efforts especially in the Gulf of Mexico, where three local initiatives are underway. Here too, IEA work involves a mixture of natural and social science. Stakeholders are involved through the use of three kinds of participatory modelling; results are compared across models and match well with NOAA's mathematical models. The presentation highlighted work within the Barataria Basin along the coast of Louisiana to stem the loss of coastline and a project with fishermen of Fort Myers, Florida to improve the resilience of local communities facing intermittent severe red tide events. The importance to NOAA of a "bottom-up" approach was stressed and was a common theme in the presentations. Steve Kasperski of NOAA Fisheries' Alaska Fisheries Science Center discussed efforts to incorporate humans into IEAs through "place-based participatory IEA". The presentation highlighted the case of Sitka, Alaska where researchers worked together with the community to develop indicators for seven dimensions of human well-being related to marine ecosystems. Ellen Spooner of NOAA Communications spoke directly to efforts to communicate information on IEAs to a wide variety of audiences, a theme that ran through all presentations. Interactive materials on the websites are an important part of the strategy of making data accessible; in addition, she described the use of "story maps" combining narratives, maps, data, graphs and other materials.

3 Progress Toward Completion of Each ToR

ToR A Analyse how the use of behavioural economics can support IEA/EBM implementation

The BE sub-group initiative is rooted in the BehavFish Workshop organized by WGMARS member Sarah Kraak in 2014, jointly funded by the ICES Science Fund and the Fisheries Society of the British Isles, in which WGMARS members Ingrid van Putten, Andries Richter, Dorothy Dankel and Katell Hamon also participated (Kraak *et al.* 2014). Debbi Pedreschi and Marloes Kraan soon joined the mission of exploring BE in the fisheries context. Dorothy and Sarah organized a theme session on BE at the 2016 ICES ASC in Riga, Latvia (where Andries, Dorothy and Sarah presented talks). Debbi, Katell, Dorothy, Marloes and Sarah participated in the 2017 NUDGE conference in Utrecht, the Netherlands, where they held a round-table discussion with non-fisheries nudge experts. Additional WGMARS members (Patricia M. Clay, Johanna Ferretti, and Leyre Goti) are now part of the BE sub-group for the current project, in which the group aims to write a paper on behavioural economics in fisheries, asking: Can this approach be used in marine fisheries? Has it been used before? What conditions make it effective? The new intern will help move us forward by conducting a thorough literature search. This ToR is scheduled for completion by Year 3. We are currently well-placed to meet that goal.

ToR B Review and provide guidelines for conceptual modelling to assist Regional Seas WGs

This ToR requires at least one workshop with one or more ICES Regional Seas or other IEA-related WGs during the three-year ToRs term of 2020-2022. This builds on work done in the previous ToRs period with WGINOR during WKINWA (held jointly with WGNARS) in 2017 and an informal North Sea Workshop with officials of Rijkswaterstaat (the Dutch national body responsible for roads, waterways, and water systems and part of the Ministry of Infrastructure and Water Management) in 2018. Pending a positive grant review, WGMARS, led by Debbi Pedreschi, will hold a five-day methods workshop on the use of conceptual modelling in IEAs. Participants of the workshop will inter alia be IEA WG chairs (or other interested members) as well as experts on conceptual modelling.

ToR C Evaluate the current use of ICES IEAs in support of management and advice

This ToR requires publication of a peer-reviewed paper on the current status of IEAs in the regional seas WGs by Year 2. We have completed a thorough literature review and interviews with all ten currently constituted ICES regional seas Working Groups. The Introduction, Background, and Methods sections are all in process. The interviews have all been coded by one person and are currently being coded by others in order to allow conduct of inter-rater reliability tests. Such statistical tests measure the degree of agreement among raters; in other words, they score how much homogeneity or consensus exists in the ratings given by various individual coders. Higher degrees of agreement mean more reliable results from analyses using the codes. Once this second round of coding is completed and any coding discrepancies in the application of codes are addressed by discussions among the coders, we will write the results section and then the conclusion. This ToR is scheduled to be completed by Year 2. We are on schedule to meet that timeline.

ToR D Apply Social Network Analysis as a tool to assess ICES network connectivity and preparedness to address IEAs and the ICES Science Plan

WGMARS has been interested in Social Network Analysis (SNA) since 2011. In 2013, WGMARS held its annual meeting in Stockholm in order to work closely with renowned SNA scholar Örjan Bodin (e.g. Bodin, García and Robins 2020, Bodin 2017, Bodin, Robins, McAllister, Guerrero, Crona, Tengö and Lubell 2016, Bodin and Crona 2009, Bodin, Crona, and Ernstson 2006). And in 2014, Friederike Lempe, a PhD student at the Thünen Institute of Sea Fisheries in Rostock, received a Science Fund award from ICES to continue more detailed analyses of the ICES network supervised by Örjan Bodin, Harry Strehlow (Thünen Institute) and Dorothy Dankel (University of Bergen). Current work is examining connections across ICES, using a database of 2015-2019 attendees of all Expert Groups (EGs) and Workshops (WKs). By looking at attendance records, we can quantify how central (connected) a node EG or WK is to the others in any given year. Centrality can be measured in four different ways: degree centrality, betweenness centrality, closeness centrality, and eigenvector centrality (see Table 1, below). Following, we provide a brief overview of some preliminary analyses in Tables 2, 3, and 3. For more detail, including additional tables, see Annex 3.

Table 1: Summary of different measures of connectivity used in social network analysis. Adapted from https://cambridge-intelligence.com/keylines-faqs-social-network-analysis/ by Andrew Disney

Degree centrality	It tells you how many connections each node has to other nodes in the network. You use it when you want to find very connected nodes, popular nodes, nodes that are likely to hold the most information, and nodes that can connect quickly to the wider network.
Betweenness centrality	Measures the number of times a node lies on the shortest path between other nodes. It shows which nodes are bridges between nodes in a network. It does this by identifying all the shortest paths and then counting how many times each node falls on one. It is used for finding nodes who influence the flow around a system. It is important to identify if a high betweenness value means the node holds authority over disparate clusters in a network, or just that is it at the periphery of both clusters.
Closeness centrality	Scores each node based on their "closeness" to all other nodes in the network. The measure calculates the shortest paths between all nodes, then assigns each node a score based on its sum of shortest paths. It is used to find nodes who are best placed to influence the entire network most quickly. It can help find a good "broadcaster", but is more useful to find influencers in a single cluster. The more central a node is, the closer it is to all other nodes.
Eigenvector centrality	A measure of the influence of a node in a network. It assigns relative scores to all nodes in the network based on the concept that connections to high-scoring nodes contribute more to the score of the node in question than equal connections to low-scoring nodes.

Table 2. Meta Summary statistics for ICES Expert Groups and Workshops from 2015–2019.

Year	Number of EGs	Number of Workshops	# of individuals
2015	93	42	2414
2016	96	61	2501

2017	105	49	2398
2018	103	56	2401
2019	115	71	2525

Table 3. Summary statistics (highest values) for ICES Expert Groups and Workshops from 2015–2019 for four categories of social network analysis statistics.

Year	Highest Degree (value)	Highest Betweeness (value)	Highest Closeness (value)	Highest Eigenvector (value)
2019	WKIrish6 (70)	WKIrish6 (720)	WGPDMO_2019 (1631)	WKIrish6 (0.198)
			WKEMOP_2019 (1631)	
2018	WKPELA_2018 (56)	WKEMPii (1165)	WKEMPii (25122)	WKEMPii (0.259)
2017	HAWG_data_2017 (69)	HAWG_data_2017 (1020)	WGMS_2017 (1582)	HAWG_data_2017 (0.25)
2016	WGNSSK_Reopening (54)	WGNSSK_Reopening (1005)	HAWG_2016 (993)	WGNSSK_Reopening (0.225)
2015	WKIACTDB_2015 (48)	WKIACTDB_2015 (965)	WKPELA_2016_-_Data_evaluation (1409)	WKIACTDB_2015 (0.218)

Table 3.1. A glossary of abbreviations of expert groups in Table 2.

ID	Full Name
WKIrish6	Benchmark Workshop on sharing information on the Irish Sea ecosystem, stock assessments, and fisheries issues, and scoping needs for assessment and management advice
WGPDMO_2019	Working Group on Pathology and Diseases of Marine Organisms
WKEMOP_2019	Workshop on Emerging Mollusc Pathogens
WKPELA_2018	Benchmark Workshop on Pelagic Stocks
WKEMPii	Workshop for the Review of Eel Management Plan Progress Reports (final workshop, of two total)
HAWG_data_2017	Data meeting of the Herring Assessment Working Group for the Area South of 62ºN
WGMS_2017	Working Group on Marine Sediments in Relation to Pollution
WGNSSK_Reopening	Working Group on the Assessment of Demersal Stocks in the North Sea and Skagerrak on reopening fisheries advice
HAWG_2016	Herring Assessment Working Group for the Area South of 62ºN
WKIACTDB_2015	Workshop on the review of the ICES acoustic-trawl survey database design
WKPELA_2016_-_Data evaluation	Benchmark Workshop on Pelagic Stocks: Data evaluation

There has been an increasing trend in the number of EGs, and the number of individuals in 2019 has grown by over 100 persons since 2015. While the number of individuals and workshops has fluctuated, 2019 remains the strongest year with regard to the number of EGs, WKs and individuals. Interestingly, five of the 20 top connected expert meetings in ICES in 2019 were specifically for the Celtic Sea area.

The manuscript in preparation will take a deeper dive into the formation of the Integrated Ecosystem Assessment (IEA) Regional Seas groups, which allows WGMARS to connect SNA to IEA, two Terms of Reference for the period of 2020–2022. We look forward to dialogue and feedback from the ICES community as the paper develops, since there is recognition, in SCICOM and ACOM, of the strategic significance of SNA insights of the ICES network. We will present the SNA paper at the 2021 ICES Annual Science Conference in Copenhagen.

ToR E Analyse and compare the implementation and linkages of IEA/EBM/MSP and fisheries in the EU, individual European member states, and the US

Our member reports from last year, our dedicated session this year (Year 1 of our ToRs) on the NOAA IEA Program, and the interviews conducted as research for our paper on IEAs have all deepened our understanding of the implementation of IEAs in ICES, in Europe, in the EU, and in the US. We are well-positioned to begin work on a comparative ICES report on this topic that will complement our IEA paper. This is scheduled for completion in Year 2.

4 Degree of success and future of the WG

4.1 Degree of success

4.1.1 Progress on ToRs

WGMARS made progress on all ToRs, in most cases, significant progress. ToRs A, C, and D have moved forward significantly. For ToR A, the behavioural economics project, the structure and content of a journal article is being finalized and a BE internship has been posted at WUR.

For ToR B, holding a workshop and providing guidelines on conceptual modelling, a workshop proposal is in process to submit for funding, and the NOAA IEA presentations provided several concrete examples of the use of conceptual modelling to gather stakeholder information and to incorporate that into planning processes. For ToR C, the IEA paper, a final draft is in progress. For ToR D, on social network analysis, preliminary analyses are close to complete and a journal article is in progress. For ToR E, the IEA/EBM/MSP report, we already have the presentations from last year; and, Mark Monaco's presentation on the use of IEA in NOAA's National Marine Sanctuaries specifically discussed this connection, providing more background for our planned report.

4.1.2 Hosting a Virtual Meeting

Due to COVID-19, the planned 2020 Washington, DC, USA meeting was converted to a virtual meeting. Because members would be joining the webex from both North America and Europe, we met only four hours per day (8am-12pm EST/2-6pm CET). Despite the shortened schedule we made significant progress in both planning and actual writing during the meeting by setting aside blocks for writing tasks where sub-groups could work on different pieces of writing using Google Docs and then come back to the larger group to discuss overall progress. We also assigned tasks for the other half of each day. We thus were able to move our scientific projects forward successfully.

We also found it critical to set aside 15 minutes at the start of the meeting for simply checking in with each other as we would have in-person while getting coffee and getting settled at the table. Similarly, though we could not have our traditional dinner out one evening, we set aside an additional half hour after check-in on Wednesday's meeting to share a meal together – breakfast or lunch depending on each individual's time zone. This proved very helpful to the important social bonding function of these annual meetings.

4.2 Future plans

Johanna Ferretti begins her second year as co-chair, while Patricia M. Clay has agreed to a second (and last) three-year term as co-chair. WGMARS is also actively recruiting a third co-chair from the membership, preferably an early career scientist. Ideally, this person would also add diversity in terms of discipline, location, and/or gender.

We are also planning for a virtual meeting again next year because the exact status of ease of future foreign travel is still so uncertain. A spring meeting is planned, with exact dates to be determined via a Doodle poll of the membership in January.

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Annex 1: List of participants

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Annex 2: Resolutions

ToR	Description	Background	Science plan topics addressed	Duration	Expected deliverables
A	Analyse how the use of behavioural economics can support IEA/EBM implementation	Policy evaluation in IEA requires insight into human behaviour in order to (1) predict how users respond to policy interventions, and (2) how stakeholders judge trade- offs between conflicting objectives.	6.3, 7.4, 7.5	Years 1,2,3	Peer-reviewed paper on behavioural economics for policy evaluation
B	Review and provide guidelines for conceptual modelling to assist Regional Seas WGs	Conceptual modelling, including through the use of, for instance, Mental Modeller or Bow-Tie Analysis, can aid scientists from different fields, as well as scientists and stakeholders, to facilitate improvements to their IEA activities.	5.3, 6.2, 7.5	Year 1, 2, or 3	At least one workshop with one or more ICES Regional Seas or other IEA- related WGs
C	Evaluate the current use of ICES IEAs in support of management and advice	ICES has prioritized the use of IEAs, e.g. in the Regional Seas WGs, as a tool for understanding trade-offs in fisheries policies.	1.9, 3.2, 6.1	Years 1,2	Peer-reviewed paper on the current status of IEAs in the regional seas WGs
D	Apply Social Network Analysis as a tool to assess ICES network connectivity and preparedness to address IEAs and the ICES Science Plan	Review of existing SNA paper drafts and relevant reports from previous WGMARS work; finish and submit the current SNA draft that was initiated with the ICES Science Fund; initiate updated analyses for ICES IEA EGs.	6.3, 7.4, 7.5	Years 1,2,3	Peer-reviewed paper on the SNA of ICES
E	Analyse and compare the implementation and linkages of IEA/EBM/MSP and fisheries in the EU, individual European member states, and the US	ICES supports the use of EBM and IEAs, while many EU states support MSP. There is a need to connect science done for both purposes and IEA (supported by ICES) is a tool that could be used with either EBM or MSP.	7.4, 6.1, 6.6	Years 1,2	ICES Report

Annex 3: Preliminary Report of the WGMARS SNA Sub-Group

Report on the WGMARS ongoing work in Social Network Analysis

1. Introduction

ICES is a large and unique network of scientists from the ICES Member Countries around the North Atlantic Ocean supported by the Secretariat in Copenhagen. Founded in 1902, ICES is the longest standing intergovernmental science organization. The science produced within the network happens within the Expert Groups (EGs), who usually meet annually to update time series and datasets and compile and integrate scientific data to develop models, theories and further insights on marine issues around the Atlantic and adjacent seas.

The ICES Strategic Plan states its mission as: "*To advance and share scientific understanding of marine ecosystems and the services they provide and to use this knowledge to generate state-of-the-art advice for meeting conservation, management, and sustainability goals.*" ICES' motto is: "*Science for sustainable seas.*"

But how does ICES create insights to meet its goals?

ICES, as a science institution, depends on the resources that different EGs bring to the science network. The greatest of these resources is undoubtedly the talented scientists and researchers that populate each EG. The sociology of science recognizes that science doesn't do itself, people do science, and therefore understanding social contexts, including social and institutional norms and practices in the making of science, is relevant for a critical analysis of ICES science.

1.1 Social Network Analysis within ICES, of ICES

The late Professor Douglas Wilson, sociologist from Aalborg University and co-founding member of the ICES Working group on Fishery Systems (the precursor to today's Working Group on Maritime Systems), is considered a pioneer who firmly positioned the field of the sociology of science and governance within ICES with his seminal book The Paradoxes of Transparency - Science and the Ecosystem Approach to Fisheries Management in Europe. He bequeathed to the WGMARS expert group his strong ideas of how Social Network Analysis (SNA) could give important insights into ICES work and the ecosystem approach, with this WG undertaking SNA-related work since 2011. In 2013, WGMARS held its annual meeting in Stockholm in order to work closely with renowned SNA scholar Örjan Bodin. And in 2014, Friederike Lempe, PhD student at the Thünen Institute in Rostock, received a Science Fund award from ICES to continue more detailed analyses of the ICES network under the supervision of Örjan Bodin, Harry Strehlow (Thünen Institute) and Dorothy Dankel (University of Bergen).

The underlying social theory behind our SNA is that ecosystem and sustainability science depends on strong connections among ICES EGs. Although there are many ways that scientists can passively integrate data, models, disciplines and scientific theories (e.g. through reading papers and individual scholarly work), sociologists of science pay close attention to the social connections of scientists and groups. SNA allows for a statistical analysis of how people are connected, and for purposes of ICES, we concern ourselves with how "well-connected" the ICES network is through individuals whose shared participation in different EGs "connects" the science.

Recently in January 2019, a sub-group of WGMARS met for a 3-day workshop at the Stockholm Resilience Centre to re-join Örjan Bodin to create a reliable database with updated data from the ICES Secretariat. The preliminary results were then presented in April 2020 during the WGMARS annual meeting.

Table 1 lists four main measures of quantifying how central a node (in our case, an ICES Expert Group or Workshop) is to the overall network of expert groups in a given year.

Table 1: Summary of different measures of connectivity used in social network analysis. Adapted from https://cambridge-intelligence.com/keylines-faqs-social-network-analysis/ by Andrew Disney

Degree centrality	It tells you how many connections each node has to other nodes in the network. You use it when you want to find very connected nodes, popular nodes, nodes that are likely to hold the most information, and nodes that can connect quickly to the wider network.
Betweenness centrality	Measures the number of times a node lies on the shortest path between other nodes. It shows which nodes are bridges between nodes in a network. It does this by identifying all the shortest paths and then counting how many times each node falls on one. It is used for finding nodes who influence the flow around a system. It is important to identify if a high betweenness value means the node holds authority over disparate clusters in a network, or just that is it at the periphery of both clusters.
Closeness centrality	Scores each node based on their "closeness" to all other nodes in the network. The measure calculates the shortest paths between all nodes, then assigns each node a score based on its sum of shortest paths. It is used to find nodes who are best placed to influence the entire network most quickly. It can help find a good "broadcaster", but is more useful to find influencers in a single cluster. The more central a node is, the closer it is to all other nodes.

Eigenvector centrality	A measure of the influence of a node in a network. It assigns relative scores to all nodes in the network based on the concept that connections to high-scoring nodes contribute more to the score of the node in question than equal connections to low-scoring nodes.

1. Data Overview of the ICES scientific network 2015–2019

The following is a brief analysis of ICES EGs and workshops (WKs), with a special focus on activity in 2019.

Table 1 gives an overview of the number of experts involved in the EGs and WKs the past five years. There has been an increasing trend in the number of EGs, and the number of individuals in 2019 has increased by over 100 since 2015. While the number of individuals and workshops has fluctuated, 2019 remains the strongest year as far as the number of EGs, WKs and individuals. See Tables 2,3, and 3.1, below.

Table 2. Meta Summary statistics for ICES Expert Groups and Workshops from 2015–2019.

Year	Number of EGs	Number of Workshops	# of individuals
2015	93	42	2414
2016	96	61	2501
2017	105	49	2398
2018	103	56	2401
2019	115	71	2525

Table 3. Summary statistics (highest values) for ICES Expert Groups and Workshops from 2015–2019 for four categories of social network analysis statistics.

Year	Highest Degree (value)	Highest Betweeness (value)	Highest Closeness (value)	Highest Eigenvector (value)
2019	WKIrish6 (70)	WKIrish6 (720)	WGPDMO_2019 (1631)	WKIrish6 (0.198)
			WKEMOP_2019 (1631)	
2018	WKPELA_2018 (56)	WKEMPii (1165)	WKEMPii (25122)	WKEMPii (0.259)
2017	HAWG_data_2017 (69)	HAWG_data_2017 (1020)	WGMS_2017 (1582)	HAWG_data_2017 (0.25)
2016	WGNSSK_Reopening (54)	WGNSSK_Reopening (1005)	HAWG_2016 (993)	WGNSSK_Reopening (0.225)
2015	WKIACTDB_2015 (48)	WKIACTDB_2015 (965)	WKPELA_2016_-_Data_evaluation (1409)	WKIACTDB_2015 (0.218)

Table 3.1. A glossary of abbreviations of Expert Groups listed in Table 2.

Id	Full Name
WKIrish6	Benchmark Workshop on sharing information on the Irish Sea ecosystem, stock assessments, and fisheries issues, and scoping needs for assessment and management advice
WGPDMO_2019	Working Group on Pathology and Diseases of Marine Organisms
WKEMOP_2019	Workshop on Emerging Mollusc Pathogens
WKPELA_2018	Benchmark Workshop on Pelagic Stocks
WKEMPii	Workshop for the Review of Eel Management Plan Progress Reports (final workshop, of two total)
HAWG_data_2017	Data meeting of the Herring Assessment Working Group for the Area South of 62ºN
WGMS_2017	Working Group on Marine Sediments in Relation to Pollution
WGNSSK_Reopening	Working Group on the Assessment of Demersal Stocks in the North Sea and Skagerrak on reopening fisheries advice
HAWG_2016	Herring Assessment Working Group for the Area South of 62ºN
WKIACTDB_2015	Workshop on the review of the ICES acoustic-trawl survey database design
WKPELA_2016_-_Data evaluation	Benchmark Workshop on Pelagic Stocks: Data evaluation

2. ICES scientific network data for 2019 at a glance

We now take a closer look at the participant data for 2019 by ranking the top 20 best-connected EGs.

- Five of the 20 top connected expert meetings in ICES in 2019 were specifically for the Celtic Sea area.
- The Best connected (highest Degree Centrality): *The Benchmark Workshop on sharing information on the Irish Sea ecosystem, stock assessments, and fisheries issues, and scoping needs for assessment and management advice* (WKIrish6)
- The Best "Bridge-maker", aka the EG that most influence the flow around other EGs, is also WKIrish6.

The WKIrish workshop series was designed to bring transdisciplinary issues together, using different modelling approaches and other methods. WKIrish6 was the final WK meeting in this series, so it is logical that this was a major event in the ICES network in 2019.

The Best "Broadcaster" or "Influencer" in the 2019 ICES network is found by the measure of Closeness centrality, which calculates the shortest paths between all EGs, then assigns each EG a score based on its sum of shortest paths. It is used to find nodes who are best placed to influence the entire network most quickly. It can help find a

good "broadcaster", but is more useful to find influencers in a single cluster. The more central a node is, the closer it is to all other nodes.

The Working Group on Pathology and Diseases of Marine Organisms (WGPDMO) and the Workshop on Emerging Mollusc Pathogens (WKEMOP) received the highest closeness centrality scores in 2019.

Table 4. Network Analysis of ICES Expert Groups and Workshops (N=176) and the degree, betweenness and closeness centrality statistics.

Degree Ranking	Id	Degree	Betweenness	Closeness
1	WKIrish6	70	720	1171
2	WGWIDE_2019	61	406	1192
3	WGCATCH_2019	56	317	1188
4	WKESIG_2019	56	325	1188
5	WKGMSE2_2019	56	389	1192
6	HAWG_2019	55	402	1185
7	WGCSE_2019	52	263	1197
8	WGNSSK_2019	50	241	1200
9	WGMIXFISH-ADVICE_2019	47	172	1199
10	WKEO3	46	679	1200
11	IBTSWG_2019	45	267	1198
12	WGHANSA_2019_November	45	525	1201
13	WKCELTIC_2	45	131	1215
14	WGISUR_2019	44	282	1196
15	WGMEGS_2019	44	216	1200
16	WGBIE_NEPH8c	43	165	1209
17	WGIPS_2019	43	210	1214
18	WKCELTIC_1	43	165	1203
19	WKNSMSE2	43	180	1211
20	WGHANSA_Anchovy	42	154	1211
	Subsection of Regional Seas Integrated Ecosystem Assessments			
34	WGIBAR_2019	33	444	1208
68	WGINOR_2019	23	121	1230

69	WGINOSE_2019	23	93	1245
131	WGIAB_2019	8	12	1321

Table 4.1. A glossary of the full names of the expert meetings in Table 4.

Degree Ranking	Id	Full Name
1	WKIrish6	Benchmark Workshop on sharing information on the Irish Sea ecosystem, stock assessments, and fisheries issues, and scoping needs for assessment and management advice
2	WGWIDE_2019	Working Group on Widely Distributed Stocks
3	WGCATCH_2019	Working Group on Commercial Catches
4	WKESIG_2019	Workshop on evaluating survey information Celtic Sea gadoids
5	WKGMSE2_2019	Workshop on guidelines for management strategy evaluations
6	HAWG_2019	Herring Assessment Working Group for the Area South of 62ºN
7	WGCSE_2019	Working Group for the Celtic Seas Ecoregion
8	WGNSSK_2019	Working Group on the Assessment of Demersal Stocks in the North Sea and Skagerrak
9	WGMIXFISH-ADVICE_2019	Working Group on Mixed Fisheries Advice
10	WKEO3	Workshop on the design and scope of the 3rd generation of ICES Ecosystem Overviews
11	IBTSWG_2019	International Bottom Trawl Survey Working Group
12	WGHANSA_2019_November	Working Group on Southern Horse Mackerel, Anchovy and Sardine
13	WKCELTIC_2	Second Data Evaluation Workshop on Celtic Sea Stocks
14	WGISUR_2019	Working Group on Integrating Surveys for the Ecosystem Approach
15	WGMEGS_2019	Working Group on Mackerel and Horse Mackerel Egg Surveys
16	WGBIE_NEPH8c	Working Group for the Bay of Biscay and the Iberian Waters Ecoregion
17	WGIPS_2019	Working Group of International Pelagic Surveys
18	WKCELTIC_1	First Data Evaluation Workshop on Celtic Sea Stocks
19	WKNSMSE2	Workshop on North Sea Stocks Management Strategy Evaluation
20	WGHANSA_Anchovy	Working Group on Southern Horse Mackerel, Anchovy and Sardine: Anchovy subgroup

The four groups highlighted in yellow at the bottom of Table 4 are Regional Seas groups that are tasked with Integrated Ecosystem Assessments of their respective areas.

The Working Group on the Integrated Assessment of the Baltic Sea (WGIAB) interestingly has a very low degree centrality (ranking 131 out of 176 nodes), low betweenness centrality, but a high closeness centrality score. This means that WGIAB is well-placed to influence the entire network quickly, perhaps even to be a network "broadcaster" since the more central a node is, the closer it is to all other nodes in the network.

1. Next Steps

In this report, we show some simple measure of the ICES networks of expert groups and workshops for the five-year period of 2015–2019. This database will be the foundation of a peer-reviewed paper, currently in progress, by the SNA sub-group of WGMARS.

The manuscript in preparation will delve more deeply into the formation of the Integrated Ecosystem Assessment (IEA) Regional Seas groups; this allows WGMARS to connect SNA to IEA, two Terms of Reference for the period of 2020–2022. We look forward to dialogue and feedback from the ICES community as the paper develops, since there is recognition, in SCICOM and ACOM, of the strategic significance of SNA insights of the ICES network.

We will present the SNA paper at the 2021 ICES Annual Science Conference in Copenhagen.