2012/MA2/SSGHIE12 The **Working Group on Aquaculture** (WGAQUA), co-chaired by Pauline Kamermans, Netherlands, Peter Cranford, Canada, and Karin Kroon Boxaspen, Norway, will meet in Spain (probably Vigo), 31 March – 4 April 2014, to work on ToRs listed below.

WGAQUA will report on the activities of 2014 (Year 2) by 30 May 2014 to SSGHIE.

ToR descriptors

This first meeting of WGAQAU will define the direction of the group based on past ICES activities, the content of a 2012 ICES Aquaculture Discussion Paper and expert group consultations. The following three ToR descriptors will be completed in 2013.

ToR	Description	Background	Science Plan topics addressed	Duration	Expected Deliverables
a	Synthesise reports and recommendations by WGAGFM, WGPDMO, WGHABD, and WGECO on the environmental dependence and effects of aquaculture.	WGAQUA must become familiar with the work that has previously been conducted by the study groups and EGs that were combined to form WGAQUA. This activity will identify specific environmental interactions with aquaculture that have been addressed in the past by various components of the new EG to avoid duplication of efforts. The proposed 3-year ToRs for WGAQUA that were developed based on the content of the 2012 ICES Aquaculture Discussion Paper and discussions held at the aquaculture workshop during the 2012 ICES ASC will be discussed and refined through additional expert consultation. The WGAQUA chairs will cross-reference proposed work with SCICOM and relevant Expert Groups.	1.1, 2.2, 2.5,3.1, 3.3, 3.4	1,2,3	ICES EG reports
b	Synthesise previous science advice provided by ICES SGs and WGs related to sustainable aquaculture.	For WGAQUA to be able to address present and emerging issues and provide the most relevant science advice to promote the sustainable use of living marine resources and the protection of the marine environment, it must become familiar with respect to the advice that has been provided by other EGs within ICES that also address issues related to sustainable aquaculture. This activity will avoid duplication of efforts within ICES. The status of new science advisory requests will be summarized and discussed and protocols will be developed on how sustainable aquaculture advise may be provided that includes any dissenting opinions. The WGAQUA chairs will cross-reference proposed advisory work with SCICOM and ACOM and relevant	1.1, 2.2, 2.5, 3.1, 3.3, 3.4	1,2,3	ICES EG reports
c	Identify emerging aquaculture issues and related science advisory needs for	For WGAQUA to effectively address relevant issues and provide timely science advice to promote the sustainable use of living marine resources and the protection of the marine environment, it must first flag emerging	1.1, 2.2, 2.5, 3.1,3.3, 3.4	1,2,3	ICES EG reports

	maintaining the sustainability of living marine resources and the protection of the marine environment. The task is to highlight new and important issues that may require additional attention by the WGAQUA and/or another Expert Group as opposed to providing a comprehensive analysis.	issues identified by the various participants. This activity will identify and rank issues identified by the group as a whole that may require future attention by the WGAQUA or other related ICES Expert Groups, either alone or through collaborative work. The task is to highlight new and important issues that may require additional attention by the WGAQUA and/or another Expert Group as opposed to providing a comprehensive analysis. Proposals for Theme Sessions for the Annual Science Conference may evolve from this activity.			
d	Identify and assess approaches for analysing the effects of aquaculture on benthic habitats with a focus on rocky and mixed substrata bottoms. Recommend approaches to assess/monitor these habitats (*Raymond Bannister*)	Development and establishment of monitoring methodology/tools for detecting/evaluating environmental impacts of aquaculture to marine ecosystems has been a topic of considerable interest for traditional cultivation locations over the past two decades. However, most of this work has concentrated on soft substratum habitats. The gradual relocation of aquaculture facilities to deeper localities dominated by hard and mixed substrata habitats has resulted in problems with using these established monitoring tools. Therefore, there is an urgent need to establish standardized monitoring methodology/tools for hard bottom and/or mixed bottom habitats being exploited through aquaculture operations to improve sustainability.	3.1, 3.3	2.3	ICES EG report and, when possible, publish outputs in peer review literature
e	Identify and assess approaches for analysing the interactions between aquaculture and eelgrass and maerl beds. Recommend approaches to assess/monitor these habitats (*Pauline Kamermans*)	Development and establishment of monitoring methodology/tools for detecting/evaluating environmental impacts of aquaculture to marine ecosystems has been a topic of considerable interest for traditional cultivation locations over the past two decades. However, most of this work has concentrated on soft substratum habitats. Aquaulture sites are also being established in more coastal areas, at times in areas with seagrasses, maerl beds, and other sensitive habitats. Therefore, there is an urgent need to establish standardized monitoring methodology/tools for seagrass and maerl beds being exploited through aquaculture operations to improve sustainability.	3.1, 3.3	2.3	ICES EG report and, when possible, publish outputs in peer review literature
f	Analyse and assess the environmental	The management of pest species in bivalve aquaculture has received increased attention in the recent past, particularly in reference to	2.5, 3.1	2.3	ICES EG report and, when

	effects of biofouling pest management in aquaculture with an emphasis on i) chemical release, ii) benthic organic enrichment, iii) waste management, and iv) propagule pressure. Ultimately, a risk assessment framework will be developed with respect to treatments for bivalve aquaculture pests within a greater pest management framework. (*Thomas Landry*)	tunicate management in mussel farming. The development of treatment regimes and methods has been mainly focused on the efficiency of control methods and therapeutants. To manage tunicates in bivalve farms, farmers may apply a variety of chemical products (e.g. lime, vinegar) to product and/or equipment or use physical methods to remove/kill fouling tunicates. In bivalve culture, mechanical methods of tunicate removal may greatly augment the deposition of organic matter (dead and dying tunicates and other fouling species and product) to the seabed within and around culture sites. The process may also encourage the liberation of propagules (larvae or fragments of colonial species) that may hasten the spread of invasive species. To date, little work has addressed these issues. Moreover, the risk associated with the various aspects of pest management has not been evaluated within a structured format such that decisions relating to treatment options are commonly made without regard to other possibilities. Greater certainty associated with the risks surrounding various aspects of pest management will support decisions relating to various treatment options.			possible, publish outputs in peer review literature
g	Analyse and assess the environmental effects of sea lice pest management in aquaculture with an emphasis on i) therapeutant release, ii) waste management, and iii) propagule pressure. (*Karin Boxaspen and Dave Jackson*)	The management of pest species in finfish mariculture has received increased attention in the recent past, particularly in reference to sea lice management in salmon farms. The development of treatment regimes and methods has been mainly focused on the efficiency of control methods and therapeutants. To manage sea lice levels at marine cage finfish sites, aquaculture operators rely upon a number of therapeutant treatment products. These products are delivered either in-feed (e.g. SLICE® active ingredient: emamectin benzoate) or topically through bath treatment (e.g. Alphamax ™, active ingredient: deltamethrin). The active ingredients in therapeutants, regardless of their mode of application, may enter the aquatic environment through a variety of pathways (e.g. dissolution, particle transport and sedimentation) and thus may reside in the water column or accumulate in benthic ecosystems and expose non-target organisms. To date, little work has addressed these issues. Moreover, the risk associated with the various aspects of pest management has not been evaluated within a structured format such that decisions relating to treatment options are commonly made without regard to other possibilities. Greater certainty associated with the risks surrounding various aspects of pest management will support	2.5, 3.1	2.3	ICES EG report and, when possible, publish outputs in peer review literature

		decisions relating to various treatment options			
h	Assess and analyse issues relating to the attraction and repulsion of wild populations by fish and shellfish farms and of the impact of this on these populations and the individuals (*Chris Mckindsey*)	An increasing number of studies have shown that the presence of an aquaculture farm may affect wild fish and other species in a given area. Fish farms may attract wild fish because of feed and other waste products associated with farms, altered communities associated with farms, and the physical structure of farms, which may offer alternate refuges or food sources. In contrast, anecdotal evidence suggests that some fish have altered their spawning and migratory behaviour to avoid areas with farms. With respect to the attraction of fish to farms, their consumption of waste products may alter the quality of the fish (size, condition, texture, flavour, etc.). It is largely unknown how any of these factors differ at different life stages.	2.5, 3.1	2.3	ICES EG report and, when possible, publish outputs in peer review literature
i	Analyse and assess the potential ecosystem services and impacts of aquaculture, including extractive aquaculture approaches for environmental impact biomitigation (*Myriam Callier, Peter Cranford, Jens Petersen*)	The environmental interactions of mariculture are receiving more attention with respect to the negative impacts of the industry, despite the growing information on the ecosystem services that this activity can provide. Well managed mariculture generally increases the net production of its host environment by maximizing the use of natural resources, from a physical, chemical and biological perspective. Nutrient trading or bio-extraction as a mitigation measure for coastal eutrophication is a relatively new topic that is gaining considerable support from different industries and regulators. It entails trades between companies discharging excess nutrients to coastal waters and aquaculture farms that produce shellfish that can help to moderate phytoplankton concentrations and act as a nutrient sink when harvested. In addition, Integrated Multi-Trophic Aquaculture (IMTA) strives to achieve a balance between commercial production and environmental sustainability by using a natural recycling concept where the by-products from one species become inputs for another within the same culture system. Commercial scale open-water IMTA operations are being developed to reduce organic enrichment impacts in some areas. Bivalves and other economically valuable macroinvertebrates, such as sea urchins, sea cucumbers and worms, have been evaluated as components of IMTA systems and have attracted considerable industry interest. However, there are still unresolved questions regarding these extractive aquaculture approaches such as: how efficient are they (i.e. to what extend do shellfish act as nutrient sinks relative to the nutrient supplies and how much fish waste can be extracted by	2.2, 3.1, 3.3, 3.4	2.3	ICES EG report and, when possible, publish outputs in peer review literature

		shellfish and other species)? It is also important to balance the positive effect of the nutrient removal in the harvest with the potential negative effects of nutrient retention in the coastal zone that may occur as a result of the biodeposition activities of the introduced extractive species. The economic aspects in relation to nutrient trading quotas and species diversification at IMTA farms need to be evaluated. Outstanding issues exist with the integration of ocean ranching of echinoderms with fish culture and include interactions with wild stocks (and fisheries), the potential impacts (displacement?) of existing habitat, and the required ranching densities needed to offset the waste fluxes. WGAQUA will review efforts worldwide and report on the subject. As a first step, a background paper will be produced outlining the general issues and the negative and positive endpoints of mariculture and extractive aquaculture.			
j	Assess the knowledge base on acceptance of aquaculture in Marine Protected Areas (*Adele Boyd*)	The implementation of Marine Protected Areas (MPAs) can cause restrictions for fish and shellfish-farmers and conflicts between aquaculture producers and environmental authorities. Spatial planning can help in these issues. However, this is rarely a joint process of all stakeholders. The fact that the definition of an MPA is not clear contributes to that. Furthermore, the benefits of MPA's to aquaculture (i.e ecosystem services) are often not communicated. For example, shellfish produced in an MPA might provide a better image of sustainable aquaculturepractices. The WGAQUA will review guidelines such as Natura 2000, and compare the implementation in different ICES countries, identify differences between different types of MPAs and identify different management strategies. In addition potential gaps between ambition and reality will be identified, and knowledge of the impact of shellfish aquaculture in different countries will be evaluated. WGAQUA can provide science-based recommendations on such topics as criteria and thresholds for management decisions, an evaluation of present management regimes, and how to deal with the lack of baseline information.	3.1, 3.3, 3.4	2.3	ICES EG report and, when possible, publish outputs in peer review literature
k	Characterize risks, real and perceived, and potential ecological benefits associated with introducing	Aquaculture companies have, and will continue to seek access to better performing aquaculture strains, however, concerns centering on the potential ecological impacts of such introductions on local wild populations often prevents transfer requests from being granted. Characterization of risks involved with introducing foreign species of	2.5, 3.1, 3.4	2.3	ICES EG report and, when possible, publish outputs in peer review

	foreign strains and species of finfish and shellfish and other invertebrates for aquaculture purposes (*Thomas Landry and Gef mlin*)	organisms or domesticized strains for aquaculture purposes would help inform policy development and decision-makers and help to reduce conflict between aquaculture operators, regulators and other interested members of the public (traditional fishers, NGOs, etc.). There have been many published studies that have researched interactions between cultured and wild salmonids (for both aquaculture and enhancement efforts), effects of these interactions include growth and survival, reproductive interactions between wild and cultured fish, and escape mitigation. Likely a similar body of work exists for shellfish. It would be beneficial to consolidate the body of work to provide advice on the potential/perceived risks of introducing strains for culture. A review of measures to reduce or mitigate these risks would be valuable to help inform policy development and decision-makers and reduce conflict between aquaculture operators, regulators and other interested members of the public (traditional fisheries, *Fli*NGOs, etc.)			literature
1	**Special request**	**Interactions between wild and captive fish stocks (OSPAR 4/2014)** a. Recalling the conclusion of the QSR 2010 that mariculture is a growing activity in the OSPAR maritime area, EIHA 2012 considered the potential for increasing environmental pressure relating to the growth of this industry. As yet this is not an established work stream within EIHA, and Contracting Parties have requested that more information be brought forwards on this issue. This was reiterated by EIHA 2013. b. Mariculture has a number of associated environmental pressures such as the introduction of non_indigenous species, which can have ecological and genetic impacts on marine environment and especially on wild fish stocks; in addition, pressures from mariculture might include: i. introduction of antibiotics and other pharmaceuticals; ii. transfer of disease and parasite interactions; iii. release of nutrients and organic matters; iv. introgression of foreign genes, from both hatchery-reared fish and genetically modified fish and invertebrates, in wild populations; v. effects on small cetaceans, such as the bottlenose dolphin, due to their interaction with aquaculture cages c. EIHA proposes that OSPAR requests ICES to provide: i. an update on the available knowledge on	2.5, 3.1	2	ICES EG report for OSPAR

	these issues; ii. concrete examples of management solutions to mitigate these pressures on the marine environment; iii. advice on which pressures have sufficient documentation regarding their impacts to implement relevant monitoring and suggest a way forward to manage these pressures. d. It may be appropriate to explore cooperation with other competent authorities working in this field, such as the European Food Safety Authority with respect to disease transfer or parasites, or the North Atlantic Salmon Conservation Organisation (NASCO), in particular with respect to existing cooperation between NASCO and ICES on issues pertaining to pressures from mariculture. Part of this request is also adressed by WGPDMO, WGAGFM and WGMME.

Summary of the Work Plan

Year 1	Organize the work of WGAQUA and possibly propose new EGs. Discuss chairs for WGAQUA and possible new EGs. Develop workplan for ToRs depending on attendance (number of people and their expertise). Evaluate Outreach/PR activities and develop outreach plan for Year 2.
Year 2	ToR leaders will prepare an outline of each ToR report (potential publication) intersessionally and will present that at the meeting. WGAQUA members will work on ToRs c-k during the meeting depending on attendance (number of people and their expertise). Evaluate Outreach/PR activities and develop outreach plan for Year 3.
Year 3	ToR leaders prepare outline of publication intersessionally and present that at meeting. During meeting finalize products depending on attendance (number of people and their expertise). Discuss future of group.

Supporting information

Priority	High
Resource requirements	Producing leaflets, travel for SCICOM leadership to inform clients about advisory capacity of WGAQUA, travel for WGAQUA Science Advice Chair to participate in meetings where questions requiring advice are drafted.
Participants	30-40 people
Secretariat facilities	Secreterial support, Support for WebEx meetings
Financial	N/A.
Linkages to ACOM and groups under ACOM	ACOM – advice on aquaculture, WGITMO (introduced species)
Linkages to other committees or groups	Coordination and cooperation with SGSA is of high importance for WGAQUA and the chairs will consider attending the SGSA meeting in 2014 and will consider coordinating meeting time and place with SGSA with the aim of having back-to back or joint meetings in 2015.

	Other groups: WGPDMO, WGBEC, WGAGFM, WGICZM, WGITMO, WGHABD
Linkages to other organizations	European Aquculture Society
Other	See also Aquaculture discussion paper tabled at ICES Council, Oct 2012