

REPORT OF WORKING GROUP 24 ON *ENVIRONMENTAL INTERACTIONS OF MARINE AQUACULTURE*

The Working Group on *Environmental Interactions of Marine Aquaculture* (hereafter WG 24) held its second meeting on October 24, 2010 in Portland Oregon, under Co-Chairmen Dr. Katsuyuki Abo (Japan), Dr. Brett Dumbauld (U.S.A.), and Ms. Ingrid Burgetz (Canada). The list of participants and the meeting's agenda can be found in *WG-24 Endnotes 1* and *2*.

AGENDA ITEM 1

Welcome and introductions

Ms. Ingrid Burgetz provided welcome remarks which were followed by round table introductions. WG 24 members from Canada, Japan, Korea, Russia, the United States and were present. Observers from Canada, China, and Russia and also participated in the meeting. The agenda was reviewed; no comments or modifications were made.

The ability of WG 24 to re-define priorities within the overall Working Group (WG) Terms of Reference (TOR), and linking the activities to broader PICES activities was discussed. It was noted that the WG can select priorities based on interest and expertise of the members, and that these priorities would then be presented to the two parent Committees (MEQ and FIS) for approval. As this is the last year of WG 24's mandate, it was emphasized that the WG needs to demonstrate how marine aquaculture fits within PICES and the FUTURE program. Dr. Toyomitsu Horii (Japan) reported that he had attended the inter-sessional FUTURE workshop in Seoul, Korea (August 16–18, 2010) on behalf of the WG. There is a good fit for WG 24 within the FUTURE program, particularly in areas such as management of coastal resources and climate change.

AGENDA ITEM 2

Review of TOR activities from 2009-2010 and proposals for action items for 2010

Discussion of list of marine aquaculture–environment interactions

Through the circulation of documents via e-mail over the past few months, the WG 24 has agreed on categorizing the types of marine aquaculture and environment interactions. The WG discussed this categorization and as a result of this discussion the following modified list of interactions (separation of release of nutrients, non-cultured organisms and organic materials) are:

- Pest and pathogen interactions/management
- Benthic habitat interactions/alterations
- Chemical release
- Genetic interactions
- Alteration in nutrients/harmful algal blooms/eutrophication
- Release of non-cultured organisms
- Release of organic materials
- Effect of noise
- Alteration in light
- Marine mammal/bird interactions

Dr. Jack Rensel (U.S.A.) suggested that WG 24 broaden environmental interactions to include harmful algal blooms and eutrophication. He also noted that alteration in nutrients covers both water column and benthic impacts although it usually implies water column. He stressed that an important contribution of the WG is the opportunity to compare and contrast approaches used in different member countries.

As part of the process in developing the categories of marine aquaculture-environment interactions, WG members were requested to identify the most important interactions for their country. Importance was defined as from an environmental, societal and/or economic perspective. Participants at the WG meeting were asked to confirm and/or comment on their responses. The following table identifies which interactions, by country, were identified as being most important.

Canada	<p>Wild/cultured species interactions:</p> <ul style="list-style-type: none"> ▪ Disease interactions ▪ Pest management
China	<ul style="list-style-type: none"> ▪ Disease interactions: bidirectionality of disease transfer; diseases impacting shrimp production are of particular importance. ▪ Genetic interactions
Japan	<ul style="list-style-type: none"> ▪ Pest and pathogen management ▪ Benthic interactions/ ▪ Alteration in nutrients
Korea	<ul style="list-style-type: none"> ▪ Pest and pathogen interactions ▪ Genetic interactions ▪ Benthic habitat interactions ▪ Alteration in nutrients
Russia	<p>Wild/cultured species interactions:</p> <ul style="list-style-type: none"> ▪ Alteration of nutrients/pollution ▪ Disease interactions
USA	<ul style="list-style-type: none"> ▪ Pest and pathogen interactions ▪ Benthic habitat interactions ▪ Alteration in nutrients

Action Item: Ms. Burgetz will revise the list based on discussions (revised above) and will re-circulate the list to WG 24 members.

Discussion of Term of Reference 2: Risk assessment

TOR-2 Country reports

Ms. Ingrid Burgetz and Dr. Jay Parsons (Canada) provided a brief update on the upcoming change in responsibility for the regulation of aquaculture in British Columbia, Canada. The federal government, through the Department of Fisheries and Oceans will be assuming responsibility for regulating aquaculture with the exception of issuing licenses for siting of new aquaculture operations, which will still be the responsibility of the Province of British Columbia.

Dr. Galina Gavrilova (Russia) provided a brief country report indicating that the concept of risk and of risk assessment is not as popular in Russia as it is in Canada or the U.S.A. Russia is not a member of the World Trade Organization, and aquaculture activities are regulated by laws of the Russian Federation. The State standards and requests are issued by several ministries and agencies under the government of Russia (Federation Federal Fishery Agency, Ministry of Nature Protection and others). There are several law-making documents that regulate environmental quality and habitat alteration control for safety of seafood. The primary documents are: (1) List of maximal permissible concentrations for fisheries grounds; and (2) Federal sanitary norms and rules. In these documents the federal norms for toxic substances, heavy metals, organic pollutants and others have been established.

Dr. Brett Dumbauld (U.S.A.) provided information on recent changes in US shellfish aquaculture regulations. The US Army Corps of Engineers is responsible for permitting shellfish aquaculture and recently issued a new nation-wide permit with regional administration and review. The new regulations are being phased in, and the nationwide permit covers existing aquaculture activities but does not cover new ones. Approaches at the regional and state levels are still being worked out. Some activities and species are regulated only under the national permit, while others will require additional information and different approaches, and there may be additional regulations at the state-level. From the aquaculture industry perspective, these differences in regulations may pose problems.

Dr. Jack Rensel provided an update on the expansion of fish farming in the State of Washington, which is expanding on Indian tribal lands along the Columbia River. Specifically, the Colville Tribe, a self-governed tribe, has control and oversight of aquaculture activities rather than the State of Washington or the US Environmental Protection Agency. Dr. Rensel is working to make sure the expansion is done with an eye to carrying capacity. There is also expansion of aquaculture in the Juan de Fuca Strait, with large companies focusing on black cod and salmon.

No other country comments were received.

Ms. Ingrid Burgetz noted that each country takes a different approach to addressing the question of risks associated with aquaculture. In preparation for the WG 24 meeting at PICES-2009 in Jeju, Korea, members were asked to identify the mechanisms and methods currently being used to assess environmental interactions of aquaculture. The report, re-circulated prior to the WG meeting at PICES-2010, was proposed to form the basis of the WG's activities under TOR-2. The report is currently unfinished, and in need of revising by various member countries, due in part to some legislative changes. It was noted that the original response from Korea was mistakenly omitted from the report circulated, and that Russia's country report contains additional details to be included in this report.

It was proposed that the report from Japan could be used as a template for revising country responses. Specifically, members will be asked to identify the legislative framework for aquaculture in their country, and the current status of research on environmental assessment of aquaculture.

Action:

- WG Co-Chairmen will re-send the report with the suggestion to members to consider using the same approach as Japan for answering the original question.
- Each member will review their contribution to the TOR-2 report from 2009 and provide updates and revisions, as required, by **December 15, 2010**.

(Originally the agreed on date was November 30, 2010; however, the Co-Chairmen have agreed that a minimum of 30 days is appropriate for WG members to be able to gather and submit the additional details).

Note: This report, once finalized, will be WG-24's final activity under TOR-2.

Discussion of Term of Reference 3: Disease interactions

Dr. Dumbauld introduced the term of reference for Activity 3, and provided a brief overview of the status of the 2009 report on TOR-3, and options for activities under TOR-3. An example was whether the WG wants to look at new methods for disease diagnostics.

WG 24 briefly discussed whether the 2009 report should be further refined, and what purpose a revised report would serve. Dr. Lori Gustafson (U.S.A.) has agreed to take the lead role in coordinating a more comprehensive report on disease interactions and suggested that one way of dividing up the TOR-3 would be to focus on the following different components:

- (1) describe current strategies re: surveillance, diagnostics and reporting;

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- (2) describe methods to detect interactions (transmission between wild and farmed), including bringing together some information on what is going on in each member country;
- (3) describe emerging diseases of concern;
- (4) model the risks of emerging diseases – developing an approach to predicting the probability of disease occurring.

Realistically, WG 24 is unlikely to be able to address each of these components, and it was suggested that the WG not focus on detection and modeling of risks of interactions. The WG agreed in principle that the output should include an overview of diseases of aquaculture in the North Pacific, with different country inputs and provide an overall picture of where the disease research community as a whole might focus. This report should be targeted as a review for publication in a peer-reviewed journal. In addition to the existing WG members, a discussion on how to further engage experts in each of the member countries took place as additional expertise was agreed to be important to allow for a more comprehensive review.

TOR-3 Country Reports

Dr. Kong Jie (China, observer) provided an update on the on-farm use of diagnostic kits for viruses of aquaculture concern (*i.e.*, white spot in shrimp culture), stating that although there are now 8 to 10 viruses that can be diagnosed with these kits that have been under development in China for a number of years, farmers do not like to use the kits as they do not assist in addressing the disease, only identifying it.

Dr Gavrilova noted that diseases of aquaculture animals are a great problem in Russia, as in other countries. In Russia, there are Handbooks for the regulation of aquaculture operations in fresh water. However, until recently a special control agency for marine aquaculture products did not exist. Disease monitoring of marine aquaculture products is conducted only by research institutes. These results are then presented to the Federal Fishery Agency. The first results of research investigations in experimental hatcheries were presented in Russia's country 2009 report.

Dr. Myoung Ae Park (Korea) noted that the focus in Korea is diagnostics: surveys on fish farms and discussions with fish farmers about diagnostic methods and treatment options such as the use of vaccines, *etc.* Work is also focusing on prevention, through the development of vaccines (including viral and bacterial disease vaccines) and chemical approaches. OIE listed diseases are important.

Dr. Abo provided a brief introduction of the Japanese situation. Japanese members of the WG will provide information on diseases, diagnostics and vaccines.

Dr. Stewart Johnson (Canada) provided an overview of aquaculture-related disease and health research and scientific efforts in Canada, which are a combined effort between government, universities, First Nations and diagnostic laboratories. Diseases and pests of concern include sea lice, IHNV, *Renibacterium*, and *Aeromonas*. He noted the importance of understanding both the host biology and reaction and the information about pathogens of concern – where they occur, their natural prevalence in wild populations, survival outside of hosts, *etc.* He then provided a more detailed overview of the types of research that are being undertaken on sea lice and IHNV as examples, as well as research on developing new tools to assess the health of mussels and littleneck clams.

Action:

- WG members who work on disease will meet on October 25, 2010 to develop a draft Table of Contents for TOR-3 and to discuss how to move forward on this activity. The developed draft Table of Contents can be found in *WG-24 Endnote 3*.
- A report, designed for submission to a peer-reviewed journal, will be developed, using the Table of Contents with draft country reports due to Dr. Lori Gustafson on **April 1, 2010**.

Country leads for this activity are: Stewart Johnson (Canada); Valeriya Terekhova (Russia); Myoung Ae Park (Korea); Katsuyuki Abo (Japan); Lori Gustafson (U.S.A.).

Note: No country lead has been identified for China.

Discussion of Term of Reference 1: Modeling interactions

Dr. Abo provided an overview of TOR-1. He reviewed the 2009 report, including a summary of the types of culture methodologies used in each member country. At the PICES-2009 it was decided that WG 24 would use functional groups rather than individual species. The table was modified to summarize by functional groups (*i.e.*, netpen carnivorous fish, long line/raft filter feeders, sowing culture filter feeders, detritus feeders).

Similar to the activities that will be undertaken for TOR-3, a proposal had been sent to WG 24 members so that the WG could build on presentations given at the PICES-2008 and -2009 mariculture sessions that focused on benthic interactions. This proposal was discussed at length, and the consensus was that benthic interactions are too narrow for a focus. The WG agreed that the focus for a literature review and analysis under TOR-1 will be on:

Short- and long-term effects on the near and far-field benthic environment, including physical and chemical changes and rates of recovery. This will include beneficial as well as negative effects.

It was determined that by focusing efforts on near and far-field interactions, this would be sufficiently comprehensive for all member countries to contribute to the review. Additionally, it was noted that the review should include an analysis of algal culture, which has both positive and negative effects in the near and far-field. Dr. Jie described new work to look at integrated aquaculture to consider the economics as well as ecological factors. He thought that chemical and other factors are likely being considered in this research.

Action:

- WG members interested in TOR-1 will meet on October 25, 2010 to develop the Table of Contents (see *WG-24 Endnote 4*) for a report addressing the focal statement, and to finalize a plan to move this activity forwards.
- The report on near and far-field interactions will be developed by WG members identified as leads (see below), using the Table of Contents (see *WG-24 Endnote 4*) with draft country reports to be submitted to Dr. Abo on **April 1, 2010**.

Country leads for this activity are: Ingrid Burgetz (Canada); Galina Gavrilova (Russia); Hung Jeong Lim (Korea); Katsuyuki Abo (Japan); Brett Dumbauld (U.S.A.).

Note: No country lead has been identified for China.

AGENDA ITEM 3

Proposal for a Topic Session at PICES-2011

A proposal for a scientific Topic Session at the upcoming PICES meeting in Khabarovsk, Russia in 2011 was developed (*WG-24 Endnote 5*). Through discussions, WG 24 decided that the inclusion of socio-economic considerations related to marine aquaculture and environment interactions would be valuable and aligns with the FUTURE program. The WG requested a full day for the session, and support for 2 invited speakers.

WG 24 discussed the possibility of using the Topic Session as the basis for putting together a special publication in the new journal *Aquaculture Environment Interactions*. It was decided that should the proposal for a Topic Session be accepted, then the WG would again initiate this discussion, as it would help to inform who should be approached as invited speakers as well as other researchers whose presentations and input would be valuable to the session. Drs. Gavrilova, Dumbauld, and Abo agreed to be co-convenors and lead this activity.

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AGENDA ITEM 4

Review of action items and deliverables for 2010–2011

Ms. Burgetz reviewed the action items and deliverables for 2010–2011 and emphasized that this was the last year of WG 24 under the current mandate, and that it is very important that the WG produce the agreed-on reports under all three TOR. She emphasized the need to stick to the April 1, 2011 deadline for submitting country reports because the activity leads and WG Co-Chairmen will then require time to analyze the reports and write the report's introduction and the analysis and discussion sections. The report will then be circulated to the WG members at the end of August 2011 for their review and comments in September and October 2011, prior to the WG meeting at PICES-2011.

In addition to developing and finalizing the reports on each TOR, over the next year WG 24 will need to consider what recommendations they would like to put forward to the two parent Committees, MEQ and FIS, for future mariculture-related activities for PICES, including Topic Sessions, requesting that the TOR of WG 24 be re-evaluated and extended, or proposing TOR for a new working group.

The WG meeting at PICES-2011 will need to focus on finalizing the reports, consider any proposals for mariculture-related topic sessions or workshops for PICES-2012 and discuss and finalize any recommendations for future PICES work on mariculture that can be proposed to the MEQ and FIS committees.

WG-24 Endnote 1

WG-24 participation list

Members

Katsuyuki Abo (Japan, Co-Chairman)
Ingrid Burgetz (Canada, Co-Chairman)
Brett Dumbauld (U.S.A., Co-Chairman)
Galina Gavrilova (Russia)
Graham Gillespie (Canada)
Lori Gustafson (U.S.A.)
Toyomitsu Horii (Japan)
Stewart Johnson (Canada)
Hyun-Jeong Lim (Korea)
Myoung Ae Park (Korea)
Jack Rensel (U.S.A.)
Tamiji Yamamoto (Japan)

Observers

Kong Jie (China)
Jay Parsons (Canada)
Olga Lukyanova (Russia)
Steven Rumrill (U.S.A.)
Darlene Smith (Canada)

WG-24 Endnote 2

WG-24 meeting agenda

1. Welcome and introductions
2. Overview of TOR activities from 2009–2010 and proposals for action items for 2010
 - List of interactions
 - TOR-2: Finalizing 2009 report and country updates
 - TOR-3: 2009 report, country updates and 2010 activities
 - TOR-1: 2009 report, country updates and 2010 activities
3. Proposal for a Topic Session or Workshop at PICES-2011

4. Review of action items and deliverables for 2010–2011
 - Reports
 - Topic Session proposal
 - Proposal for future marine aquaculture work in PICES

WG-24 Endnote 3

Pathogens of aquatic animals: Detection, diagnosis and risks of interactions between wild and farmed populations in PICES member countries

1. Executive Summary
2. Introduction
3. Status Review by Country

Each country will submit a document reviewing some or all of the following topics. If possible countries will identify key concerns, critical information sources and primary organizations and/or regulations directing aquatic animal health. However, it is not expected that these reviews will be exhaustive. Rather, countries may choose to highlight select diseases, diagnostics or epidemiologic methods of regional importance and/or provide a foundation or direction for future research.

3.1 Topics

3.1.1 Pathogens of importance to wild and cultured aquatic animals by country

- May include information on invertebrates and/or finfish
- May include diseases of importance as defined by the OIE, as well as diseases of regional or country significance.
- May consider economic and/or ecological significance.

3.1.2 Overview of the regulations/rules regarding aquatic animal health

- Identification of departments or agencies involved in the regulation and/or control of aquatic animal diseases
- Brief review of the regulatory environment

3.1.3 Overview of national and/or regional programs related to the diagnosis and control of diseases of aquatic animals

- Identification of laboratories/departments etc. that are actively involved in disease diagnostics and/or research related to diagnostic test development

3.1.4 Overview of the methods used for the identification and detection of pathogens of concern

- To include diagnostic tests approved for regulatory use as well as those that are used within the research community.

3.1.5 Overview of perceived or realized risks associated with the transfer of pathogens between wild and farmed hosts

- This may include the introduction of pathogens resulting from the translocation or natural migration of animals from aquaculture or wild populations.
- This could include statistical methods, research activities or disease spread models used to study the potential transfer of pathogens.
- This could include examples or case studies of presumed disease transmission between aquaculture and wild populations.
- This could also include steps taken to reduce risk of transmission between aquaculture and wild populations.

4. Conclusion

The conclusion will summarize progress and gaps in the study of pathogen transfer between aquaculture and wild aquatic animal populations. Suggestions may include future conference sessions, new working group objectives, or peer-reviewed publications considering the need for harmonization or further development of research and surveillance methods.

WG-24 Endnote 4**Assessing environmental interactions of marine aquaculture: A review of long- and short-term, near- and far-field effects of marine aquaculture on benthic communities, including chemical and physical changes, and rates of ecosystem recovery in PICES member countries**

1. **Executive Summary**
2. **Introduction**
3. **Status Review by Country**

Each country will submit a document reviewing some or all of the following topics. It is not expected that these reviews will be exhaustive. Rather, countries may choose to highlight select research results and projects of regional importance and/or provide a foundation or direction for future research. A generalized overview/analysis may be provided to introduce the detailed information, below.

3.1 Finfish Aquaculture Review**3.1.1** Near-field effects (including short and long term, resiliency of ecosystem to perturbation)

3.1.1.1 Physical changes *e.g.*, changes to seafloor structure from deposition of feces, feed,(smothering) placement of netpen

3.1.1.2 Chemical changes *e.g.*, addition of nutrients

3.1.1.3 Biological changes *e.g.*, changes in benthic community structure

3.1.2 Far field effects (including short and long term, resiliency of ecosystem to perturbation)

3.1.2.1 Chemical changes *e.g.*, eutrophication, resuspension of nutrients, etc

3.1.2.2 Biological changes *e.g.*, algal growth, *etc.*

3.1.3 Rates of Recovery *e.g.*, following fallowing or removal of netpens, change in redox following removal of site, length of time to see change in benthic community structure to recolonization**3.2 Shellfish Aquaculture Review****3.2.1** Near field effects including short and long term, resiliency of ecosystem to perturbation)**3.2.1.1** Suspension Culture

- Physical Changes *e.g.*, changes to seafloor structure from deposition of feces, placement of rafts, and shellfish drop-off
- Chemical Changes *e.g.*, addition of nutrients
- Biological Changes *e.g.*, changes in benthic community structure

3.2.1.2 On-bottom Culture (including beach culture, and sowing)

- Physical Changes *e.g.*, direct changes to seafloor structure from epibenthic shellfish addition, and harvest activities
- Chemical Changes *e.g.*, deposition of feces and nutrient addition
- Biological Changes *e.g.*, benthic community changes

3.2.2 Far field effects (including carrying capacity considerations)**3.2.2.1** Suspension Culture

- Chemical Changes
- Biological Changes

3.2.2.2 On-bottom Culture (including beach culture, and sowing)

- Chemical Changes
- Biological Changes

3.2.3 Rates of Recovery**3.2.3.1** Suspension**3.2.3.2** On-bottom Culture (including beach culture, and sowing)**3.3 Marine Algae****3.3.1** Near field effects

3.3.1.1 Physical changes (*e.g.*, change on circulation patterns (flow))

3.3.1.2 Chemical changes (*e.g.*, reduction of nutrients)

3.3.1.3 Biological changes (*e.g.*, creation of habitat for fish, biofouling)

3.3.2 Far field effects

- 3.3.2.1 Chemical changes
- 3.3.2.2 Biological changes (e.g. causes green tide, epiphyte bloom, increase in productivity)
- 3.4 Polyculture/Integrated Multi-Trophic Aquaculture
- 4. Discussion, Analysis, Recommendations, Future (and FUTURE) Analysis
- 5. References

WG-24 Endnote 5

**Proposal for a 1-day MEQ/FIS Topic Session at PICES-2011 on
*“Identification and characterization of environmental interactions of marine aquaculture
 in the North Pacific”***

Convenors: Galina Gavrilova; Brett Dumbauld; Katsuyuki Abo

Marine aquaculture is an important economic and social activity within PICES member countries. To ensure development of aquaculture is environmentally and economically sustainable we need to: 1) improve our understanding of interactions between marine aquaculture and the environment (including wild stocks of plants and animals), 2) develop methods to study and/or predict such interactions, and 3) devise ways to reduce negative impacts on the environment. To this end the PICES Working Group on *Environmental Interactions of Marine Aquaculture* (WG 24) has begun to characterize the nature of these interactions with a focus on the benthic environment and aquatic animal health. To align with the activities of the WG 24 we propose to solicit papers in the following areas for this scientific session:

1. identification and characterization of marine aquaculture-environmental interactions;
2. development of tools to identify and study such interactions; and
3. social science research related to aquaculture interactions with the marine environment.

Duration: full day

A request was made for financial support for two invited speakers.