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Interim Report of the Working Group on Pathology and Diseases of Marine Organisms (WGPDMO)

14–18 February 2017

Gdynia, Poland

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CIEM Conseil International pour l'Exploration de la Mer

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Executive summary

The ICES Working Group on Pathology and Diseases of Marine Organisms (WGPDMO) met on 14–18 February 2017 at the National Marine Fisheries Research Institute, in Gdynia, Poland. The meeting was chaired by Ryan Carnegie (USA) and attended by six participants, with seven ICES Member Countries represented.

The agenda included several topics related to diseases and pathology in wild and farmed fish and shellfish. The group produced a report on new disease trends in wild and farmed fish and shellfish in the ICES area based on national reports from fourteen member countries. Notable reports for wild fish included new observations of salmon gill poxvirus in eastern Canada after a single, initial observation in 2015; continued increase in the prevalence of *Contracaecum osculatum* in Polish waters; increase in the prevalence of *Anisakis simplex* in Barents Sea waters of Russia; and continued unexplained mortality in salmon in the Barents and Baltic Seas. Reports for farmed fish included detection of infectious pancreatic necrosis virus in salmon and sea trout from Latvia; expansion of the distribution of salmonid rickettsial septicaemia in western Canada, with observations also in Ireland; and increasing occurrence of cardiomyopathy syndrome in salmon in Ireland. Additionally, amoebic gill disease remains a challenge for Atlantic salmon culture in the ICES region. New observations continued to be made of pathogens in cleaner lumpfish, including in Iceland viral haemorrhagic septicaemia virus, and in Ireland a ranavirus, *Piscirickettsia salmonis*, and *Exophiala*. Notable observations for shellfish included continued association of OsHV-1 µvars with mortality of young Pacific oyster in France, and expansion of their known distribution in England; continued detection of *Vibrio aestuarianus* in the context of some mortality events in Ireland; expansion of the distribution of *Bonamia ostreae* in Ireland; and presumed involvement in mortality events of *Vibrio splendidus* in Mediterranean mussel in France, a *Paramarteilia* in velvet crab in Ireland, and *Perkinsus olseni* in carpet clam in Portugal. Observation again in 2016 of a *Marteilia* infecting Pacific oyster in Europe warrants further investigation given potential implications for management. Observation of "wild-type" OsHV-1 in England is remarkable in revealing the persistence of non-µvar lineages of this pathogen in at least one European location.

Work on additional documents included a summary of the role of *Vibrio* pathogens contributing to mortalities in shellfish aquaculture, a synthesis on the contemporary status of oyster pathogen *Bonamia ostreae*, and a description of the distribution of amoebic gill disease in marine salmon farms, all to be prepared for publication in scientific journals; and a compilation of pathogen screening in wild salmonids, to be presented in the final WGPDMO report.

Two new and one revised ICES Identification Leaflets for Diseases and Parasites of Fish and Shellfish were published, including 'Brown ring disease: a vibriosis affecting clams', 'Bonamiosis of oysters', and '*Exophiala salmonis*'. Two additional leaflets have been submitted, and completion of thirteen new leaflets is planned.

1 Administrative details

Working Group name

Working Group on Pathology and Diseases of Marine Organisms (WGPDMO)

Year of Appointment

2016

Reporting year within current cycle (1, 2 or 3)

2

Chair(s)

Ryan B. Carnegie, USA

Meeting venue

Gdynia, Poland

Meeting dates

14–18 February 2017

2 Terms of Reference a) – z)

ToR a) Summarize new and emerging disease trends in wild and cultured fish, molluscs and crustaceans based on national reports.

ToR b) Deliver leaflets on pathology and diseases of marine organisms.

ToR c) Synthesize information on the spread and impact of *Bonamia ostreae* in flat oysters in the ICES area.

ToR d) Summarise the role of *Vibrio* sp. pathogens contributing to mortalities in shellfish aquaculture.

ToR e) Prepare a report describing the occurrence and spread of amoebic gill disease (AGD) in marine salmonid farming in the ICES area.

ToR f) Compile information on pathogen screening of wild salmonids in the ICES member states.

ToR g) Evaluate applicability of the Fish Disease Index (FDI) by using the R package following newly developed guidelines.

ToR h) Provide expert knowledge and management advice on fish and shellfish diseases, if requested, and related data to the ICES Data Centre.

ToR i) Generate a standard reporting template to improve data collection concerning sample sizes and pathogen prevalences.

3 Summary of Work plan

ToR a) New disease conditions and trends in diseases of wild and cultured marine organisms will be reviewed. This is an annual, ongoing ToR for WGPDMO and will provide information for ToRs c-f.

ToR b) A number of ICES publications currently in preparation will be reviewed by WGPDMO. This is an ongoing, annual ToR.

ToR c) *Bonamia ostreae* is a major pathogen of European flat oysters that has expanded its range in recent years. The present distribution, recent trends in parasite prevalence and infection intensity, and the effectiveness of contemporary management strategies will be summarized, with a perspective on the related species *Bonamia exitiosa*, recently documented in oysters from some ICES member countries.

ToR d) *Vibrio* bacteria have long been associated with larval production problems in shellfish hatcheries, but the potential impacts of vibriosis in sub-market and market-sized Pacific oysters in European production areas has become an important emerging concern. This ToR will synthesize the current knowledge on *Vibrio* impacts and highlight critical gaps in our understanding of these species.

ToR e) Amoebic gill disease (AGD) has emerged as a significant issue for salmon farming in the Atlantic. This ToR will produce a report describing the spread and impact of this disease and current measures being used to mitigate its effects. It will identify knowledge gaps and future areas for research.

ToR f) Many ICES member countries screen wild broodstock used for restocking purposes for disease pathogens. This ToR will produce a report compiling information on diseases and methods used in order to prepare a common approach to screening and assess the effectiveness of current practices.

ToR g) This ToR will produce an assessment of the applicability of the Fish Disease Index based on its trial use by participants from among the group.

ToR h) This is an annual ToR in compliance with a requests from the ICES Data Centre.

ToR i) This ToR will allow improved resolution of disease trends in ICES member countries.

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

- A report on new disease trends in wild and farmed fish and shellfish in ICES Member Countries, which is the only annual expert report available on this topic.
- Publication of ICES Disease Leaflet No. 65: Brown ring disease: a vibriosis affecting clams *Ruditapes philippinarum* and *R. decussatus* (Paillard, new leaflet), No. 66: Bonamiosis of oysters caused by *Bonamia exitiosa* (Carnegie, new leaflet), and No. 42: Infection with *Exophiala salmonis* (Bruno, revised leaflet).

- Submission of a new ICES Disease Leaflet on Gonadal neoplasia in bivalves (Renault) as well as a revision of No. 11: Disseminated neoplasms in bivalves (Renault & Ford).
- Finalisation of the ICES Cooperative Research Report titled New trends in important diseases affecting farmed fish and molluscs in the ICES areas (Ruane and Carnegie, editors, ICES reference no. 2013/1/SSGHIE06.
- Report of the Workshop to address the NASCO request for advice on possible effects of salmonid aquaculture on wild Atlantic salmon populations in the North Atlantic (WKCULEF), co-authored by Jones, WGPDMO representative to the workshop

5 Progress report on ToRs and workplan

5.1 Summarize new and emerging disease trends in wild and cultured fish, molluscs and crustaceans based on national reports (ToR a)

The update in the following sections is based on national reports for 2016 submitted by Canada, Denmark, England & Wales, Finland, France, Germany, Ireland, Latvia, the Netherlands, Poland, Portugal, Russia, Sweden and the USA. It documents significant observations and highlights the major trends in newly emerging diseases and in those identified as being important in previous years.

5.1.1 Wild Fish

Viruses

Lymphocystis – In waters of England and Wales, there was a marked absence in dab from the Irish Sea (with the exception of North Cardigan Bay where the prevalence was 5%).

Salmon Gill Poxvirus (SGPV) – In eastern Canada, the virus was detected by qPCR in 12 of 213 Atlantic salmon in 2016 following detection in a single salmon in 2015. The virus was not detected in any of 90 brook char from the same region. Genomic sequences from the Canadian virus were 80-85% similar to the known Norwegian sequence.

Viral Haemorrhagic Septicaemia Virus (VHSV) – In Sweden, genotype Ib was detected in Atlantic herring from Kattegat and Skagerrak (ICES subdivision IIIa). The fish showed no clinical signs of the disease. In Canada, genotype IVa was again detected in Atlantic herring in Newfoundland after first being observed there in 2015.

Bacteria

Acute/healing skin ulcerations – In the Barents Sea (Russian EEZ), prevalence in cod, haddock and catfish remained below 1%. In the Polish EEZ, prevalence in Baltic cod declined from 2.5% to 1.7%, the lowest prevalence since 2010.

Parasites

Myxozoa

***Kudoa* sp. –** An unidentified species was detected in musculature of 1 of 10 Ballan wrasse sampled during a mortality event off the southwest coast of England.

Nematoda

Anisakidae – Polish data indicate a negative correlation between intensity of infection with anisakid larvae in liver and condition factor of cod. Each increase of 20 larvae has been found to be associated with a 1% reduction in condition factor.

***Contracaecum osculatum* –** In Polish waters, overall prevalence in cod of 35 cm or greater length continued a recent increasing trend and reached 71%. Over several years, increasing infection appears to have progressed in an easterly direction in the Baltic Sea. Data from the Danish EEZ suggest that Baltic sprat and herring serve as principal transport hosts.

***Anisakis simplex* –** In Polish waters, mean prevalence in cod of 35 cm or greater length was 6.6%, suggesting that the decline observed since 2013 has continued. In Russian waters of the Barents Sea, prevalence increased from 4% to 23% in dab and from 10% to 26% in plaice. In contrast, prevalence in navaga declined from 23% to 14%.

Other diseases

Eye Pathology – In the Barents Sea (Russian EEZ), "red-eye syndrome" was the most prevalent pathology, with an average prevalence of 2% in over 11 species. This represents an increase from 0.6% in 2015. The condition was most frequently observed in capelin (4.4%), polar cod (3.0%) and herring (2.7%). The aetiology of this condition is not known.

Hyperpigmentation – The condition in dab from the North Sea continues to be 2 to 3 times more prevalent than in the Irish Sea.

Unexplained salmon mortality – Unexplained mortality persists among adult Atlantic salmon and pink salmon in rivers in Russia, Sweden and Finland. Efforts are underway to determine a cause

Conclusion

- Salmon gill poxvirus was detected in approximately 6% of 213 Atlantic salmon in eastern Canada. The genomic sequence of the Canadian virus was 80%-85% similar to a Norwegian sequence.
- VHSV genotype IVa was detected in Atlantic herring in Newfoundland for the first time in 2015 and again in 2016.
- Prevalence of *Anisakis simplex* in dab and plaice increased in the Barents Sea.
- Prevalence of *Contracaecum osculatum* in Baltic cod in Polish waters continues to increase.
- High morbidity and mortality persist among migrating salmon in Russia, Finland and Sweden, and investigations are ongoing.

5.1.2 Farmed Fish

Viruses

Infectious pancreatic necrosis virus (IPNV) – In Latvia, IPN was detected in five ranched Atlantic salmon and sea trout parr and smolts from five farms. IPN was originally found on a rainbow trout farm in 2013. The genotype has not been identified.

Piscine myocarditis virus (PMCV) – In Ireland, cardiomyopathy syndrome was diagnosed in 4 Atlantic salmon farms in 2016, up from 0 in 2015 and 1 in 2014.

Viral haemorrhagic septicaemia virus (VHSV) – Viral genotype IV was detected in diseased wild-caught lumpfish broodstock and their progeny in a rearing facility in Iceland in 2015.

Lumpfish ranavirus – In Ireland, a ranavirus was isolated from juvenile lumpfish at a rearing facility. Although the fish were undergoing mortality at the time, it is not clear if the virus contributed to mortality. Ranaviruses have been isolated from healthy lumpfish broodstock in Iceland, Faroe Islands and Scotland in the past two years.

Bacteria

Flavobacterium psychrophilum – In Denmark, the pathogen was isolated from diseased eels cultured in seawater. Due to recurrent problems with ulcers in the eel batch expected to be caused by vibrios, the salt percentage in the water had been lowered by adding freshwater, and *Vibrio anguillarum* was in fact isolated from an ulcer in one of the eels, where *F. psychrophilum* was found in inner organs.

Piscirickettsia salmonis – In western Canada, the range of salmonid rickettsial septicaemia in Atlantic salmon expanded to 6 fish health management zones in 2016. The disease occurred on 2 Atlantic salmon farms in Ireland and was also reported in lumpfish, for the first time.

Fungi

***Exophiala* sp. –** In Ireland, adult lumpfish were diagnosed with an *Exophiala* sp. (possibly *E. angulospora*) infection at a rearing facility. Mortality was low, but all fish were culled due to the chronic nature of the disease and lack of effective treatments.

Conclusions

- The number of cases of cardiomyopathy syndrome in Atlantic salmon in Ireland is increasing.
- Ranaviruses have been isolated from lumpfish in Iceland, Faroe Islands, Scotland and Ireland. Further work is required to determine their identity and pathogenicity to lumpfish as well as Atlantic salmon.
- Rickettsiosis was recorded in lumpfish for the first time, in Ireland.

5.1.3 Wild and farmed molluscs and crustaceans

Viruses

Oyster Herpesvirus – Real-time PCR-confirmed cases of OsHV-1 infection of spat (‹ 1 year) were observed in Pacific oyster in France (12 of 13 spat samples) sampled in association with mortality events (from 10–60%). None of the 12 spat batches demonstrated real-time PCR-confirmed cases of *Vibrio aestuarianus* infection. These observations are assumed to represent the presence of an OsHV-1 μvar, as "reference strain" OsHV-1 has been reported to be entirely replaced by the OsHV-1 μvar in France.

In England, the OsHV-1 μvar was detected by PCR and sequencing during routine monitoring in August 2016 of a population of wild Pacific oyster off the NW Isle of Sheppey, at Sheerness, expanding the known distribution of this pathogen on the North Kent coast. Further north, farmed Pacific oysters in the River Deben in Suffolk, a location not known to be positive for OsHV-1, tested positive in routine monitoring. Sequencing revealed the pathogen present to be a "wild-type" form and not an OsHV-1 μvar, indicating persistence of non-microvariant OsHV-1 genotypes in at least one European location.

In Portugal, Pacific oyster experienced high mortality (up to 90% in both adults and juveniles) from September-November 2015 in Ria de Aveiro in the north, and Alvor and Formosa coastal lagoons in the south, as well as in offshore longlines at Sagres Bay on the south coast. Although the profile of mortality, reaching very high levels in adults as well as juveniles and peaking so late in the season, does not fit the typical profile of an OsHV-1 μvar event, OsHV-1 DNA was detected by PCR in oysters from most samples from all four areas. External factors such as unusually high water temperatures and high oyster planting densities may have contributed to the unusual mortality.

In western Canada, a total of 225 real-time PCR tests on 1050 domestic Pacific oyster were negative for OsHV-1, continuing a trend from prior years of no OsHV-1 detection and providing further evidence that Pacific oyster populations in western Canada are OsHV-1-free.

Bacteria

***Vibrio aestuarianus* –** The bacterium was detected in adult Pacific oyster in 5 of 16 bays in Ireland impacted by mortality. Mortality levels were lower than those observed in 2015.

***Vibrio* spp. –** In France, vibrios belonging to the *V. splendidus* group were detected by PCR in Mediterranean mussel collected in Charente Maritime, Vendée, Loire Atlantique, Brittany and Normandy. Mortality among 16 batches of mussels ranged from 5-50%, and all batches tested positive, with one batch additionally PCR-positive for *V. aestuarianus*, indicating a possible contribution of *Vibrio* infection to mortality.

Parasites

Bonamia ostreae – In Ireland, *Bonamia ostreae* was detected in European flat oyster sampled from Kilkieran Bay, Co. Galway, in December, the first detection of the parasite in this area. No mortality appeared to be associated with the finding and an epidemiological investigation of the potential source of the introduction is ongoing.

In Denmark, *B. ostreae* was detected in European flat oyster in 2 of 3 areas in the eastern Limfjorden, as was also seen in 2014 and 2015. The parasite was again not detected in the sampling area Nissum Bredning, providing further evidence that the western Limfjorden is free of *B. ostreae*.

***Marteilia* sp. –** For the second successive year in France, *Marteilia* sp. was detected by histology at low levels in spring samples of adult Pacific oyster, where 5 of 159 oysters were positive with no associated mortality. Given the importance to management of marteiliosis in the region, it is important that the identity of this parasite be determined.

***Paramarteilia* sp. –** In the context of investigation into a velvet crab fishery collapse in inner Galway Bay, Ireland, *Paramarteilia* sp. was detected in 67 of 141 velvet crab. DNA sequencing suggests that the species is *P. orchestiae* or a closely related species. The parasite was observed at very high infection intensities in many of the infected crabs, and thus is thought to have caused or contributed to the mortalities.

Haplosporidium nelsoni – In Chesapeake Bay waters of Maryland, USA, mean prevalence in 43 fall samples of 30 eastern oyster increased from 7% to 11% between 2015 and 2016, likely a result of increasing salinities in the region during a period of drought.

***Haematodinium* sp. –** In Galway Bay, Ireland, a *Haematodinium* sp. was detected in 5 of 141 velvet crab during investigation into a fishery collapse. The infections were unlikely to have contributed substantially to the mortality but represent a first observation of the parasite in this host from Ireland.

***Perkinsus marinus* –** Mean prevalence in eastern oyster increased from 47% to 58% in lower Chesapeake Bay waters of Virginia, USA, based on autumn samples of twenty-five oysters from each of thirty natural oyster reefs. This increase ended a trend of decreasing prevalence extending back to 2010 and was likely due to elevated salinities during drought being more favorable for the parasite. Despite the increase, *P. marinus* prevalence remained below the lowest quartile for annual mean data from the 1989-present period. Reported mean *P. marinus* prevalence in the upper, Maryland portion of Chesapeake Bay changed little from 2015, increasing from 61% to 63% in fall samples of thirty oysters from each of forty-three natural reefs. Reports from the northeastern USA and from the Gulf of Mexico indicate no change to *P. marinus* relative to previous years.

***Perkinsus olseni* –** In Portugal, mortalities of carpet-shell clam were reported in Formosa and Alvor lagoons from September-November 2015. *Perkinsus olseni* was found in 6 samples (n=180) in juveniles and adults. Infections reached moderate-heavy intensities, which are rare in juveniles under one year of age, and a prevalence of the disease close to 60%. Adults had similar infection intensities and prevalences over 80%. The massive mortalities may have resulted from the combination of *P. olseni* infection and elevated temperatures and salinities, or hypoxia.

Fungi

Microsporidian sp. – In Galway Bay, Ireland, a microsporidian was detected in 3 of 141 velvet crab during investigation of a fishery collapse. This represents the first detection of a microsporidian infection in velvet crab in Ireland.

Epizootic shell disease – In Sweden, carapace pathology consistent with epizootic shell disease was observed in 3 of 3 exotic American lobster captured on the west coast.

Other diseases

Summer mortality in eastern oyster – Continuing a trend extending back several years, summer mortality was observed at several aquaculture farms in Virginia waters in Chesapeake Bay, USA. Mortality typically occurs between May and early July, and affects the most robust, fastest growing oysters planted the previous year (12–15 months of age), of which 30% may be lost in a typical year and over 70% in extreme years. There are no obvious histopathological or other signs of disease. Mortality occurs primarily in polyhaline creeks of the lower bayside Eastern Shore of Virginia, and is thought to primarily affect triploid oysters. The possibility that the condition represents a physiological disorder related to triploidy interacting with as yet unidentified environmental stressors is being investigated.

Conclusions

- OsHV-1 μvars continue to be significant pathogens of Pacific oyster in Europe.
- Mortality of Pacific oyster at locations in Portugal occurred in 2015, with OsHV-1 detected and possibly contributing to mortality.
- Reported Pacific oyster mortalities in Ireland were lower in 2016 than in 2015.
- Mediterranean mussel mortality occurred in several locations in Atlantic waters of France, with *Vibrio splendidus* detected in samples from affected populations.
- *Bonamia ostreae* expanded its distribution in Ireland to Kilkieran Bay.
- *Marteilia* sp. was detected once again at low prevalence in Pacific oysters from France.
- High prevalence and intensities of *Paramarteilia* sp. were observed in velvet crab in Ireland following collapse of a fishery in Galway Bay.
- *Perkinsus olseni* infection contributed to mortality in carpet clam at locations in Portugal.
- Summer mortality in eastern oyster from locations in Chesapeake Bay, USA, is an emerging concern.

5.2 Deliver leaflets on pathology and diseases of marine organisms (ToR b)

At the 2015 WGPDMO meeting it was agreed that all disease leaflets should be updated during the next 3 years and that effort should be made to increase the visibility and relevance of the leaflets.

Since the 2016 meeting the following new leaflet has been published.

No. 65: Brown ring disease: a vibriosis affecting clams *Ruditapes philippinarum* and *R. decussatus* (Paillard)

Please note that this disease leaflet is the very first ICES product with a DOI number (http://doi.org/10.17895/ices.pub.1924).

In addition, the revised Leaflet No. 42 Infection with *Exophiala salmonis* (Bruno) was also published.

The following leaflet has been submitted to ICES and will be published in the near future:

* Bonamiosis of oysters caused by *Bonamia exitiosa* (Carnegie) (new leaflet).

The following revised and new leaflets are currently with the editor and will be published during 2017.

* No. 11 Disseminated neoplasms in bivalves (Renault & Ford)

* New leaflet: Gonadal neoplasia in bivalves (Renault)

It remains important for the WGPDMO to continue to propose titles of new leaflets and to suggest potential authors for these so that the series remains current with up to date and relevant information. In addition, the editor has contacted selected authors for production of further revised leaflets which are to be submitted during 2017. As part of the ongoing task to update all remaining leaflets more than ten years old the WGPDMO reviewed the list of published leaflets and identified members to either take responsibility to produce a revised leaflet or to propose an alternative author to the editor.

The current list of emerging disease conditions that should generate a new disease leaflet is provided below:

1) Mikrocytos spp.
2) Ostreid herpesvirus
3) Infectious Salmon Anaemia (ISA)
4) Pancreas Disease (PD)
5) Haematodinium
6) X-cell in dab
7) Vibriosis in oysters
8) Tenacibaculosis in farmed fish
9) Vibriosis in farmed salmonids
10) Sphaerothecum in dab
11) Mycobacteriosis in wild fish
12) QPX in hard clams

5.3 Synthesize information on the spread and impact of *Bonamia ostreae* in flat oysters in the ICES area (ToR c)

Bonamiosis is a disease notifiable both to the OIE and the EU (under Directive 2006/88/EC) which has recently spread to new areas. The first recording of bonamiosis dates back more than 35 years, and from 1979 to the present there has been abundant information collected regarding the spread, current distribution and potential impact of the disease in ICES member countries as well as the effectiveness of management strategies for controlling the disease. The WGPDMO will synthesize this information with the help of experts within this field who will be involved in producing a review on the subject. The review will be based on published papers and WGPDMO reports as well as reports from the annual meeting of EU national reference laboratories for mollusc diseases, and will consider changes in pathogen distribution with human activities and changing climate. The group will perform a meta-analysis of long-term prevalence, intensity and mortality data where available to provide new perspective on possible adaptation of oysters to bonamiosis exposure that would be relevant to management of fisheries and aquaculture populations.

5.4 Summarise the role of *Vibrio* sp. pathogens contributing to mortalities in shellfish aquaculture (ToR d)

Vibrio bacteria pathogenic to Pacific oysters and other bivalve molluscs have been increasingly documented in WGPDMO national reports from the last several years, with 2015 no exception. Whilst it is becoming increasingly apparent that particular species such as *V. aestuarianus* and *V. splendidus* are involved in mortalities observed in aquacultured bivalves in natural waters, additional species have been reported as pathogens in hatchery and nursery environments, for example in 2015 in Spain. Still, there exists a lack of clarity in relation to the pathogenic role of different vibrios, particularly where multiple species or other pathogens such as the OsHV-1 μVar are detected in a single event. The WGPDMO will provide a synthesis on the current state of knowledge relating to these pathogens through a review of the existing literature and data from events which have occurred in recent years, with a view toward identifying key knowledge gaps to be addressed through future research. The group's objective will be to elucidate the established roles of different *Vibrio* species in mortalities in both wild and aquaculture populations. Concurrently, a new EU project "Vivaldi" (*Preventing and mitigating farmed bivalve diseases*) includes among its aims an examination of the roles of the pathogens OsHV-1 and *Vibrio* species and their interactions. Relevant Vivaldi participants will be included as collaborators in the review being undertaken by the WGPDMO to ensure that the review is informed by results from the Vivaldi project.

5.5 Prepare a report describing the occurrence and spread of amoebic gill disease (AGD) in marine salmonid farming in the ICES area (ToR e)

The final report will include the following sections, presented in preliminary draft form below.

Introduction

Amoebic gill disease is caused by infection with the amphizoic amoeba *Paramoeba* (syn. *Neoparamoeba*) *perurans* (Amoebozoa: Dactylopodida). Untreated disease is most significant in seawater-reared Atlantic salmon with reported mortality up to 80%. A recent review (Oldham *et al.*, 2016) provides a summary of the incidence and distribution of amoebic gill disease. Clinical AGD has been reported from 14 countries in 15 fish species from around the world. Documented risk factors for AGD include unusually high temperature events and high salinity. The purpose of this report is to describe the spread, impact and measures used currently to mitigate effects of the disease in the ICES area. Knowledge gaps and future areas for research will be identified. We will summarise the most recent published literature and data from WGPDMO national reports.

Occurrence within ICES member countries

AGD was first described from marine netpen-reared salmon in Tasmania over 40 years ago and has since been reported from virtually all salmon-rearing countries. Among ICES member countries, AGD was first reported in 1995 in Ireland, France and Spain. After a gap of 11 years, AGD was first reported from Scotland and Norway in 2006, from Orkney and Shetland (Scotland) in 2012 and for the first time from the Faroe Islands in 2014. Infection with *P. perurans* and AGD was also first reported from western Canada in 2014. The extent to which the new findings constitute a spread of *P. perurans* among ICES member countries or the de novo emergence of the disease due to local environmental factors is not well understood.

Impact within ICES member countries

The impacts of AGD among ICES member countries has ranged from minor to major and have presented as sporadic to recurring problems. AGD emerged as a significant issue in 2011, with reports of high mortalities in marine farmed Atlantic salmon in France and Ireland (70–80%), followed by reports from Scotland later that year. In 2012 the disease reoccurred in those countries and reports of AGD in Norway began to emerge, followed in later years by reports in the Faroe Islands and Canada. The impact of early outbreaks in France and more recent outbreaks in the Faroe Islands and Canada have been minor. In France and Canada, outbreaks occur sporadically. Following the initial outbreaks, the introduction of fish health management practices e.g. gill screening and regular treatments, have reduced the average mortality rates in all countries affected. The early outbreaks of AGD in Spain had a major impact and led to the halting of salmon aquaculture in that country.

Treatment

Two methods are presently used to treat AGD. Bathing fish in freshwater (<3 ppt for 2–4 hours) is primarily used in Ireland and some parts of Norway, whereas immersion in hydrogen peroxide is more common in Scotland and much of Norway where access to suitable quantities of freshwater is limited.

Knowledge gaps

The recognition of AGD among species of wrasse and in the lumpfish, all used as sea lice cleaner fish in salmon aquaculture, raises concerns about the role of cleaner fish in the epidemiology of AGD among salmon. A better understanding is needed of the interactions among host predisposition, amoeba abundance, and a range of environmental variables (e.g., temperature, salinity, microbial communities on the gill). Also, the emergence of AGD in seawater-reared salmon has raised the awareness of gill health more generally, resulting in more systematic monitoring of gills on production sites. AGD is now recognized as part of a spectrum of gill disorders classified as proliferative gill disease (PGD) or proliferative gill inflammation (PGI). PGD and PGI can be multifactorial and associated with viral, bacterial and/or parasitic aetiologies. Conditions involving mixed AGD and PGD/PGI have recently been referred to as complex gill disease (CGD). There is a need to further our understanding of the relationships between AGD and PGD/I and associated environmental or biological factors which predispose the fish to disease.

5.6 Compile information on pathogen screening of wild salmonids in the ICES member states (ToR f)

Many ICES member countries screen wild broodstock used for restocking purposes for disease pathogens. Over the next year, the WGPDMO will compile information on diseases and methods used in these screening efforts. The goal of the report is to describe the screening methods used, pathogens screened for and results to determine the practicalities of adopting a common approach to screening.

Interactions between farmed and wild fish may play a role in the spread of important diseases within the aquaculture industry. Aquaculture can create conditions of increased host population density, leading to a higher prevalence of pathogens which can have limited impacts on wild fish but can emerge as serious diseases in aquaculture. These pathogens can become magnified in populations of farmed fish and may cause spillback to wild populations, particularly to those populations in close proximity to the fish farms. Likewise, reservoirs of infection can also be created in wild fish populations that have the potential to spread the infection to other aquaculture areas.

There is limited data available in the published literature on the prevalence of aquatic pathogens in wild fish due to the fact that the majority of wild fish have been screened as pathogen negative. This report will utilise both published and unpublished reports to compile data on wild fish screening in order to meet the goals stated above. A number of these reports have already been collated and will be analysed over the next year, in conjunction with the published literature.

Sample reports:

- Annual report on health monitoring of wild anadromous salmonids in Norway. 2015. Reports by the Norwegian Veterinary Institute and the Institute for Marine Research.
- Status update on the surveillance of wild and enhance anadromous salmonids in British Columbia. 2014. A report by the Canadian Food Inspection Agency.
- Epidemiology and control of an outbreak of VHS in wrasse around Shetland commencing 2012. 2013. Report by Marine Scotland Science.
- An epidemiological investigation of wild fish in Shetland in 2009 for the presence of ISAV. 2009. Report by Marine Scotland Science.
- IPN virus and its impact on the Irish salmon aquaculture and wild fish sectors. 2007. Report by the Marine Institute.

5.7 Evaluate applicability of the Fish Disease Index by using the R package following newly developed guidelines (ToR g)

The present version of the R package is able to perform following actions: read rawfish disease data (ICES format or user-supplied), calculate descriptive statistics, calculate disease prevalence including confidence limits (per area, over time), calculate FDI values (raw and standardized, per individual and per population), do assessment of FDIs based on BAC and EAC in a traffic light fashion, display the assessment on a map, do a long-term trend assessment. Standard versions of the FDI for common dab (*Limanda limanda*), cod (*Gadus morhua*) and flounder (*Platichthys flesus*), are included in the package. The package also contains features to define new FDI and to derive new BAC and EAC. User input to the programme is done via an Excel spreadsheet into which all necessary inputs are entered. At present, this spreadsheet has to be stored and subsequently the user has to start the R programme manually. This procedure will be simplified by allowing users to start the programme directly from the Excel interface. The programme will subsequently be circulated to volunteering WGPDMO members for testing.

5.8 Provide expert knowledge and management advice on fish and shellfish diseases, if requested, and related data to the ICES Data Centre (ToR h)

Members of the WGPDMO continue to provide support to the ICES Data Centre in relation to the clarification of details concerning the submission of data.

WGPDMO member Simon Jones participated in a workshop to address the NASCO request for advice on possible effects of salmonid aquaculture on wild Atlantic salmon populations in the North Atlantic [WKCULEF], Copenhagen, Denmark, 1–3 March 2016. WKCULEF met to consider a question posed to ICES by the North Atlantic Salmon Conservation Organisation (NASCO): *Advise on possible effects of salmonid aquaculture on wild Atlantic salmon populations focusing on the effects of sea lice, genetic interactions and the impact on wild salmon production*.

This question was originally included among a suite of questions developed by NASCO, and due to be addressed by the annual meeting of the Working Group on North Atlantic Salmon (WGNAS). However, given that the question was pertinent to other Expert Groups at ICES, particularly the Working Group on Aquaculture (WGAQUA), the Working Group on Pathology and Diseases of Marine Organisms (WGPDMO) and the Working Group on the Application of Genetics in Fisheries and Mariculture (WGAGFM), it was recommended that the question would be best addressed by means of a Workshop, independent of the Working Groups. WKCULEF enabled experts in aquaculture effects, wild Atlantic salmon, disease transmission and genetic interaction to share and discuss relevant information and recent findings, in order to meet the objectives and timeline of the request.

The terms of reference were addressed though a comprehensive review of the recent peer-reviewed literature. This was facilitated by a range of presentations from participants, by reviewing working documents prepared ahead of the meeting as well as the development of documents and text for the report during the meeting. The report (ICES, 2016) is structured in two main sections, one focusing on the effects of sea lice and the other on genetic interactions. The third issue specified in the question from NASCO, namely the impact of salmon farming on wild salmon production, has been relatively poorly researched and most information derives from attempts to evaluate population level effects related to sea lice infestation and genetic introgression. This information has therefore been reported in the sea lice and genetics sections of the report, respectively.

Reference

ICES. 2016. Report of the Workshop to address the NASCO request for advice on possible effects of salmonid aquaculture on wild Atlantic salmon populations in the North Atlantic (WKCULEF), 1–3 March 2016, Charlottenlund, Denmark. ICES CM 2016/ACOM:42. 44 pp.

6 Revisions to the work plan and justification

None.

7 Next meetings

The 2018 meeting of the WGPDMO, the final meeting of this reporting cycle, will take place in Riga, Latvia, 13–17 February 2018.

Annex 1: List of participants

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Annex 2: Common and scientific names of host species in the report

capelin	*Mallotus villosus*
char, brook	*Salvelinus fontinalis*
clam, carpet shell	*Ruditapes decussatus*
clam, hard	*Mercenaria mercenaria*
clam, Manila	*Ruditapes philippinarum*
cod, Atlantic	*Gadus morhua*
cod, Baltic	*Gadus morhua*
cod, Polar	*Boreogadus saida*
crab, velvet	*Necora puber*
dab, common	*Limanda limanda*
eel, European	*Anguilla anguilla*
flounder, European	*Platichthys flesus*
haddock	*Melanogrammus aeglefinus*
herring, Atlantic	*Clupea harengus*
lobster, American	*Homarus americanus*
lumpfish	*Cyclopterus lumpus*
mussel, Mediterranean	*Mytilus galloprovincialis*
navaga	*Eleginus nawaga*
oyster, Eastern	*Crassostrea virginica*
oyster, European flat	*Ostrea edulis*
oyster, Pacific	*Crassostrea gigas*
plaice, European	*Pleuronectes platessa*
salmon, Atlantic	*Salmo salar*
salmon, pink	*Oncorhynchus gorbuscha*
sprat, Baltic	*Sprattus sprattus*
trout, rainbow	*Oncorhynchus mykiss*
wrasse, Ballan	*Labrus bergylta*