



**REPORT OF THE MEETING OF THE OIE *AD HOC* GROUP ON SUSCEPTIBILITY
OF FISH SPECIES TO INFECTION WITH OIE LISTED DISEASES¹**

Paris, 2–4 May 2018

The OIE *ad hoc* Group on Susceptibility of fish species to infection with OIE listed diseases (the *ad hoc* Group) met for their fourth meeting at OIE Headquarters from 2 to 4 May 2018.

The list of participants and the Terms of Reference are presented in [Annex I](#) and [Annex II](#), respectively.

Dr Stian Johnsen, Standards Department, welcomed members to this meeting and thanked the *ad hoc* Group for their ongoing work on this important topic.

The chair of the *ad hoc* Group, Dr Mark Crane, clarified that the primary purpose of this meeting was to finalise applying the criteria to host species to determine susceptibility to infection with infectious haematopoietic necrosis virus (IHNV) and to start work on applying the criteria to determine susceptibility to infection with viral haemorrhagic septicaemia virus.

The *ad hoc* Group applied the three-stage approach, outlined in Article 1.5.3. of the *Aquatic Code*, to assess susceptibility of a species to IHNV, as described below:

- 1) criteria to determine whether the route of transmission is consistent with natural pathways for the infection (as described in Article 1.5.4.);
- 2) criteria to determine whether the pathogenic agent has been adequately identified (as described in Article 1.5.5.);
- 3) criteria to determine whether the evidence indicates that presence of the pathogenic agent constitutes an infection (as described in Article 1.5.6.).

Stage 1: criteria to determine whether the route of transmission is consistent with natural pathways for the infection (as described in Article 1.5.4.)

Route of infection Key

N: Natural infection.

E: Experimental (non-invasive).

EI: Experimental (invasive).

Most references that reported invasive experimental procedures as the route of transmission were not assessed beyond Stage 1 (i.e. Article 1.5.4.).

¹ Note: This *ad hoc* Group report reflects the views of its members and may not necessarily reflect the views of the OIE. This report should be read in conjunction with the September 2018 report of the Aquatic Animal Health Standards Commission because this report provides its considerations and comments. It is available at <http://www.oie.int/en/standard-setting/specialists-commissions-working-ad-hoc-groups/aquatic-animals-commission-reports/meeting-reports/>

Stage 2: criteria to determine whether the pathogenic agent has been adequately identified as described in Article 1.5.5.

Accurate pathogen identification might not have been carried out in older publications because molecular typing techniques were not available at the time. In these circumstances a weight of evidence approach, using combined data from relevant studies, were considered and used to assess susceptibility.

Stage 3: criteria to determine whether the evidence indicates that presence of the pathogenic agent constitutes an infection as described in Article 1.5.6.

Criteria A to D in Article 1.5.6. were used to determine if there was sufficient evidence for infection with the pathogenic agent in the suspect host species. Evidence to support criterion A alone was sufficient to determine infection. In the absence of evidence to meet criterion A, satisfying at least two of criteria B, C or D were required to determine infection.

- A. The pathogenic agent is multiplying in the host, or developing stages of the pathogenic agent are present in or on the host;
- B. Viable pathogenic agent is isolated from the proposed susceptible species, or infectivity is demonstrated by way of transmission to naïve individuals;
- C. Clinical or pathological changes are associated with the infection;
- D. The specific location of the pathogen corresponds with the expected target tissues.

Hosts that were classified as susceptible species (as described in Article 1.5.7.) were proposed for inclusion in Article 10.6.2. of Chapter 10.6. 'Infection with infectious haematopoietic necrosis virus' of the *Aquatic Code*.

Hosts that were classified as species for which there is partial evidence for susceptibility (as described in Article 1.5.8.) were proposed for inclusion in a new Section 2.2.2. *Species with incomplete evidence for susceptibility* of Chapter 2.3.4. 'Infectious haematopoietic necrosis' of the *Aquatic Manual*.

The detailed assessments for IHNV assessed by the *ad hoc* Group are provided in Annex III.

The *ad hoc* Group wished to note the following:

The *ad hoc* Group requested that another physical meeting be held in 2018 to continue assessments for infection with viral haemorrhagic septicaemia virus and to start assessments for infection with red sea bream iridovirus.

.../Annexes

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Terms of reference

Background

A new Chapter 1.5. ‘Criteria for listing species as susceptible to infection with a specific pathogen’ was introduced in the 2014 edition of the *Aquatic Code*. The purpose of this chapter is to provide criteria for determining which host species are listed as susceptible in Article X.X.2. of each disease-specific chapter in the *Aquatic Code*. The criteria are to be applied progressively to each disease-specific chapter in the *Aquatic Code*.

These assessments will be undertaken by *ad hoc* Groups and the assessments will be provided to Member Countries for comment prior to any change in the list of susceptible species in Article X.X.2. of the disease-specific chapters in the *Aquatic Code*.

For species where there is some evidence of susceptibility but insufficient evidence to demonstrate susceptibility through the approach described in Article 1.5.3., information will be included in the relevant disease-specific chapter in the *Aquatic Manual*.

Purpose

The *ad hoc* Group on Susceptibility of fish species to infection with OIE listed diseases will undertake assessments for the ten OIE listed fish diseases.

Terms of Reference

1. Consider evidence required to satisfy the criteria in Chapter 1.5.
2. Review relevant literature documenting susceptibility of species for OIE listed fish diseases.
3. Propose susceptible species for OIE listed diseases for fish based on Article 1.5.7.
4. Propose susceptible species for OIE listed diseases for fish based on Article 1.5.8.

Expected outputs of the *ad hoc* Group

1. Develop a list of susceptible species for inclusion in the relevant Article X.X.2. of fish disease-specific chapters in the *Aquatic Code*.
 2. Develop a list of species with incomplete evidence for susceptibility for inclusion in Section 2.2.2. of the *Aquatic Manual*.
 3. Draft a report for consideration by the Aquatic Animals Commission at their September 2018 meeting.
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ASSESSMENT OF HOST SUSCEPTIBILITY TO INFECTION WITH INFECTIOUS HAEMATOPOIETIC NECROSIS VIRUS

Criteria for susceptibility to infection with infectious haematopoietic necrosis virus (IHNV) are detailed in Table 1 (as per Article 1.5.6. of the *Aquatic Code*). This table includes Replication (A), Viability/Infectivity (B), Pathology/Clinical Signs (C) and Location (D). Hosts were considered to be infected with IHNV if they fulfilled either criterion A, or at least two of criteria B, C and D (as per point 3 of Article 1.5.7. of the *Aquatic Code*).

Table 1. Criteria for susceptibility to infection with IHNV

A: Replication	B: Viability / Infectivity *	C: Pathology / Clinical signs	D: Location*
Sequential virus titration showing increase in viral titres or high virus titres in internal organs ($>10^5$ TCID ₅₀ /g) OR TEM OR Immunohistochemistry OR Product of virus replication detected	Isolation of virus from internal organs by cell culture OR Passage to a susceptible host	Gross signs include lethargy interspersed with bouts of frenzied, abnormal activity, darkening of the skin, pale gills, ascites, distended abdomen, exophthalmia, and petechial haemorrhages externally. Internally, pathology includes petechial haemorrhages in visceral organs and/or muscle and heart; necrotic kidney, spleen, liver, swollen spleen, anaemia and ascites.	Recover virus from internal organs OR RT-PCR from internal organs

* Where gills and intestine are used, surface contamination should be ruled out.

Pathogen identification for IHNV:

Pathogen isolation on EPC, FHM, or CHSE cell lines with confirmation using immunological or molecular test. Immunological test could include virus neutralization, IFAT, or ELISA. Molecular tools include RT-PCR, DNA probes, sequencing. RT-PCR could also be done directly on infected tissues.

ASSESSMENT FOR HOST SUSCEPTIBILITY

The assessments for host susceptibility to infection with IHNV are provided in [Table 2](#).

Table 2. Outcome of assessments for host susceptibility to infection with IHNV

Genus	Species	Common name	Stage 1: Transmission ¹	Stage 2: Pathogen identification	Stage 3: Evidence for infection ²				Outcome	References
					A	B	C	D ³		
<i>Salmo</i>	<i>salar</i>	Atlantic Salmon	N and E	Culture, neutralisation and RT-PCR	ND	Y	Y	Y	1	Armstrong <i>et al.</i> , 1993; St-Hilaire <i>et al.</i> , 2002
<i>Salmo</i>	<i>trutta</i>	Brown trout	E and N	Culture confirmed with serum neutralization published in other LaPatra <i>et al.</i> , 1990 paper	ND	Y	Y	N	1	LaPatra <i>et al.</i> , 1990; Rexhepi <i>et al.</i> , 2011
<i>Salmo</i>	<i>marmoratus</i>	Marble trout	E	Culture and PCR	ND	Y	Y	Y	1	Pascoli <i>et al.</i> , 2015
<i>Salvelinus</i>	<i>namaycush</i>	Lake trout	E	Culture and DNA probe	Y	Y	Y	N	1	Follett <i>et al.</i> , 1997
<i>Salvelinus</i>	<i>fontinalis</i>	Brook trout	N	Culture and RT-PCR and IFAT	Y	Y	Y	Y	1	Zhu <i>et al.</i> , 2013; Bootland <i>et al.</i> , 1994
<i>Salvelinus</i>	<i>alpinus</i>	Arctic char	E	Culture and ELISA	ND	Y	Y	N	1	McAllister <i>et al.</i> , 2000

Genus	Species	Common name	Stage 1: Transmission ¹	Stage 2: Pathogen identification	Stage 3: Evidence for infection ²				Outcome	References
					A	B	C	D ³		
<i>Oncorhynchus</i>	<i>tshawytscha</i>	Chinook salmon	N	Culture and serum neutralisation	Y	Y	Y	N	1	Follett <i>et al.</i> , 1987; Arkush <i>et al.</i> , 2004; St-Hilaire <i>et al.</i> , 2001
<i>Oncorhynchus</i>	<i>keta</i>	Chum salmon	N	Culture and serum neutralisation	ND	Y	Y	N	1	Follett <i>et al.</i> , 1987; Yoshimizu <i>et al.</i> , 1993
<i>Oncorhynchus</i>	<i>kisutch</i>	Coho	N	Culture and serum neutralisation	Y	Y	N	Y	1	Eaton <i>et al.</i> , 1991; LaPatra <i>et al.</i> , 1989; Helmick <i>et al.</i> , 1995; Hedrick <i>et al.</i> , 1995
<i>Oncorhynchus</i>	<i>masou</i>	Masu salmon	N	Culture and immunoassay	ND	Y	N	Y	1	Yoshimizu <i>et al.</i> , 1993
<i>Oncorhynchus</i>	<i>mykiss</i>	Rainbow trout	E and N	Culture and RT-PCR	ND	Y	Y	Y	1	Pascoli <i>et al.</i> , 2015; LaPatra <i>et al.</i> , 1993; Haenen <i>et al.</i> , 2016
<i>Oncorhynchus</i>	<i>nerka</i>	Sockeye salmon	E	Culture and DNA probe	Y	Y	Y	N	1	Follett <i>et al.</i> , 1997; Yoshimizu <i>et al.</i> , 1993
<i>Oncorhynchus</i>	<i>masou rhodurus</i>	Biwa trout subspecies of Masu	Subspecies of Masu (see Masu salmon)						1	Yamazaki & Motonishi, 1992
<i>Oncorhynchus</i>	<i>clarkii</i>	Cutthroat trout	E	Culture of known isolate 220-90	ND	Y	Y	N	1	LaPatra <i>et al.</i> , 1994
<i>Clupea</i>	<i>pallasii</i>	Pacific Herring	N	Virus culture and DNA probe or neutralization test	ND	Y	N	N	2	Kent <i>et al.</i> , 1998; Hart <i>et al.</i> , 2011
<i>Cymatogaster</i>	<i>aggregata</i>	Shiner perch	N	Virus culture and DNA probe or Neutralization test	ND	Y	N	N	2	Kent <i>et al.</i> , 1998

Annex III (contd)

Genus	Species	Common name	Stage 1: Transmission ¹	Stage 2: Pathogen identification	Stage 3: Evidence for infection ²				Outcome	References
					A	B	C	D ³		
<i>Aulorhynchus</i>	<i>flavidus</i>	Tube-snout	N	Virus culture and DNA probe or neutralization test	ND	Y	N	N	2	Kent <i>et al.</i> , 1998
<i>Acipenser</i>	<i>transmontanus</i>	White sturgeon	E/EI	Cell culture but no confirmation	Y	Y	N	N	2	LaPatra <i>et al.</i> , 1995
<i>Esox</i>	<i>lucius</i>	Northern pike	N	Culture and ELISA	ND	Y	Y	N	2	Reschova <i>et al.</i> , 2008 ; Dorson <i>et al.</i> , 1987
<i>Lota</i>	<i>maxima</i>	Burbot	E	Culture and PCR	ND	Y	N	N	2	Polinski <i>et al.</i> , 2010
<i>Oncorhynchus</i>	<i>gorbuscha</i>	Pink salmon	E	Culture negative	ND	N	N	N	3	Follett <i>et al.</i> , 1997
<i>Thymallus</i>	<i>thymallus</i>	Grayling	E	Culture negative	ND	N	N	N	3	Follett <i>et al.</i> , 1997
<i>Plecoglossus</i>	<i>altivelis</i>	Ayu sweetfish	N	Gene sequencing on stored isolate	ND	N	N	N	3	Nishizawa <i>et al.</i> , 2006
<i>Anguilla</i>	<i>anguilla</i>	European eel	N	Culture but not confirmed	ND	N	N	N	3	Bergmann <i>et al.</i> , 2003; Jorgensen <i>et al.</i> , 1994
<i>Cyprinus</i>	<i>carpio</i>	Common carp	E	Culture and qRT-PCR	ND	N	N	N	3	Palmer <i>et al.</i> , 2014
<i>Perca</i>	<i>flavescens</i>	American yellow perch	E	Culture and qRT-PCR	ND	N	N	N	3	Palmer <i>et al.</i> , 2014
<i>Lepeophtheirus</i>	<i>salmonis</i>	Salmon lice	E	Culture and PCR	ND	Y	N	N	#	Jakob <i>et al.</i> , 2011
<i>Callibaetis</i>	sp.	Mayfly	N	Culture and antibody neutralisation	ND	Y	N	N	#	Shors & Winston, 1988

Invertebrate species.

¹ **Route of Infection Key**

N: Natural infection.

E: Experimental (non-invasive).

EI: Experimental (invasive).

² **Evidence for Infection Key**

ND: Not determined.

N: Evidence do not indicate that presence of the pathogenic agent constitutes an infection.

Y: Evidence do indicate that presence of the pathogenic agent constitutes an infection.

³ “N” in this column captures cases in which the tissue tested included external organs such as skin, gill, or gastrointestinal tissues or cases in which tested tissues were found negative.

Outcome system

The following outcome were assigned to each host evaluated based on the rules outlined above.

1: *Meets the criteria for susceptibility; and be included in Article 10.6.2. of Chapter 10.6. ‘IHNV’ of the Aquatic Code.*

2: *Some but not all the criteria have been met; and be proposed for inclusion in a new Section 2.2.2. Species with incomplete evidence for susceptibility of Chapter 2.3.4. ‘IHNV’ of the Aquatic Manual.*

3: *Criteria for susceptibility have not been met.*

4: *Evidence of non-susceptibility.*

Additional information relevant to assessments for IHNV

For species within the Salmonidae family, the *ad hoc* Group agreed that susceptibility could be determined based on only one study because of the broad host range of IHNV within this family. However, for animals belonging to other families the *ad hoc* Group required two studies to demonstrate susceptibility to infection with the pathogenic agent.

Turbot (*Psetta maxima*)

The *ad hoc* Group agreed the outcome for turbot be a “2” because there was no definitive identification of the virus from the fish that died in the study and the life stage of fish suggested they were not immunocompetent.

Recommendations

The *ad hoc* Group recommended that invertebrate species assessed and listed in Table 2 be included in Section 2.2.6. *Vectors* of Chapter 2.3.4. ‘Infectious haematopoietic necrosis’ of the *Aquatic Manual*. The *ad hoc* Group considered invertebrate species to be vectors for transmission of IHNV rather than true susceptible species because it was difficult to determine viral replication within the insect.

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