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## Assessment of listing and categorisation of animal diseases within the framework of the Animal Health Law (Regulation (EU) No 2016/429): Japanese encephalitis (JE)

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### Abstract

Japanese encephalitis (JE) has been assessed according to the criteria of the Animal Health Law (AHL), in particular criteria of Article 7 on disease profile and impacts, Article 5 on the eligibility of Japanese encephalitis to be listed, Article 9 for the categorisation of Japanese encephalitis according to disease prevention and control rules as in Annex IV and Article 8 on the list of animal species related to Japanese encephalitis. The assessment has been performed following a methodology composed of information collection and compilation, expert judgement on each criterion at individual and, if no consensus was reached before, also at collective level. The output is composed of the categorical answer, and for the questions where no consensus was reached, the different supporting views are reported. Details on the methodology used for this assessment are explained in a separate opinion. According to the assessment performed, JE can be considered eligible to be listed for Union intervention as laid down in Article 5(3) of the AHL. The disease would comply with the criteria as in Section 5 of Annex IV of the AHL, for the application of the disease prevention and control rules referred to in point (e) of Article 9(1). The main animal species to be listed for JE according to Article 8(3) criteria are waterfowl, pigs and equines as susceptible species and waterfowl as reservoir, as reported in the present document.

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## 1. Introduction

### 1.1. Background and Terms of Reference as provided by the requestor

The background and Terms of Reference (ToR) as provided by the European Commission for the present document are reported in Section 1.2 of the scientific opinion on the ad hoc methodology followed for the assessment of the disease to be listed and categorised according to the criteria of Article 5, Annex IV according to Article 9, and 8 within the Animal Health Law (AHL) framework (EFSA AHAW Panel, 2017a).

### 1.2. Interpretation of the Terms of Reference

The interpretation of the ToR is as in Section 1.2 of the scientific opinion on the ad hoc methodology followed for the assessment of the disease to be listed and categorised according to the criteria of Article 5, Annex IV according to Article 9, and 8 within the AHL framework (EFSA AHAW Panel, 2017a).

The present document reports the results of assessment on Japanese encephalitis (JE) according to the criteria of the AHL articles as follows:

- Article 7: Japanese encephalitis profile and impacts
- Article 5: eligibility of Japanese encephalitis to be listed
- Article 9: categorisation of Japanese encephalitis according to disease prevention and control rules as in Annex IV
- Article 8: list of animal species related to Japanese encephalitis.

## 2. Data and methodologies

The methodology applied in this opinion is described in detail in a dedicated document about the ad hoc method developed for assessing any animal disease for the listing and categorisation of diseases within the AHL framework (EFSA AHAW Panel, 2017a).

## 3. Assessment

### 3.1. Assessment according to Article 7 criteria

This section presents the assessment of JE according to the Article 7 criteria of the AHL and related parameters [see table 2 of the opinion on methodology (EFSA AHAW Panel, 2017a)] based on the information contained in the fact-sheet as drafted by the selected disease scientist (see Section 2.1 of the scientific opinion on the ad hoc methodology) and amended by the AHAW Panel.

#### 3.1.1. Article 7(a) Disease profile

JE is caused by Japanese encephalitis virus (JEV) which is a single-stranded positive sense RNA virus, enveloped, 40–50 nm diameter that belongs to an unclassified order, the family of the Flaviviridae, the genus *Flavivirus* and species JEV. It is vector-borne and occurs as a single serotype with five known genotypes (GI–GV); genotypes GIb and GII are associated with temperate climates. GIb is believed to be the dominant JEV genotype in Asia.

It causes severe encephalitis and death in a small percentage of infected humans, horses and donkeys, and reproductive failure in infected swine that have not developed immunity, with expected losses of between 50 and 70%.

##### 3.1.1.1. Article 7(a)(i) Animal species concerned by the disease

###### *Susceptible animal species*

Laboratory experiments have been carried out to determine the levels of viraemia and the duration of infectious periods:

**Waterfowl**, in particular egrets (*Egretta garzetta*) and herons (*Nycticorax nycticorax*), could produce viraemia of  $10^{3.5}$  suckling mouse intracerebral lethal dose 50% (SMIC LD50)/0.03 mL of blood, that could last 3–5 days (Buescher et al., 1959; Scherer et al., 1959; Impoinvil et al., 2013a). Since many of them are migratory birds, it seems that they are implicated in maintenance and in dissemination through vectors, when viremic.

**Swine** experimentally infected show high and prolonged viraemia [ $10^6$  SMIC LD<sub>50</sub>/mL of blood 24 h post-infection (hpi) during four or more days] and infection rates in the field reaching 98–100% can be reached in endemic regions. Intensive pig-farming coupled with rice production have a strong positive impact on JEV transmission. There is a rapid turnover in pigs since pigs 6–8 months old are taken for slaughter (Impoinvil et al., 2013a). Wild boar may play also an important role as reservoir and/or amplifier, but further studies are needed to confirm this hypothesis (Nidaira et al., 2008).

**Equines** are dead-end hosts although it has been seen in the lab that they can reach viraemia of  $10^{1.2}$  SMIC LD<sub>50</sub>/0.03 mL that can last 2–6 days.

Several species such as water buffalo, cattle, sheep, goats, dogs, raccoons (*Procyon lotor*), bats, birds, rodents, snakes and chickens may be infected by JEV with cattle, water buffalo, sheep, goats, dogs, raccoons, thought to be dead-end hosts (Peiris et al., 1993; Hamano et al., 2007; Ohno et al., 2009; Ariel, 2011; Impoinvil et al., 2013a).

Other animals could play a role as overwintering hosts. Bats, snakes, lizards and frogs develop viraemia that could infect mosquitoes during new transmission seasons (Oya et al., 1983; Wang et al., 2009). The main vector, however, has a low feeding preference for these animals but more data about this is needed (OIE, online-b).

#### *Reservoir animal species*

Waterfowl represent the main reservoir and swine the main amplifying host, based on their levels of viraemia, duration of the infectious period and asymptomatic appearance of infection.

### **3.1.1.2. Article 7(a)(ii) The morbidity and mortality rates of the disease in animal populations**

**Horses:** Studies in India reported in 2003 showed, in a suspected focal outbreak which took place in Pune, 2.67% of horses were symptomatic while 20.33% seroconverted (Raut et al., 2003). A study on the seroprevalence in 13 states reported antibodies in, on average, 10% of horses surveyed (Gulati et al., 2011).

Between 1948 and 1967, morbidity in Asia was estimated as 0.045% but during the epizootic outbreak in 1948 in Japan it was 0.3%, case fatality is approximately 5–15%. When a group of broodmares is introduced to a susceptible area, one-third of them could die (Spickler and Roth, 2006; Impoinvil et al., 2013a; OIE, online-b).

**Swine:** At the time of first detection of the virus in the Torres Strait islands, between Australia and New Guinea, between 33% and 100% of pigs had developed antibodies (AHA/AUSVETPLAN, 1998) and in a study in Japan, 68% of wild boars were seropositive (Hamano et al., 2007). Mortality in non-immune infected piglets can approach 100% (Impoinvil et al., 2013a).

No known clinical disease has been observed in other animals.

### **3.1.1.3. Article 7(a)(iii) The zoonotic character of the disease**

#### *Presence*

#### Parameter 1 – Report of zoonotic human cases (anywhere)

JEV is a zoonotic disease persisting in nature through a cycle of transmission primarily between mosquitoes, some domestic and wild birds, domestic and feral pigs, and humans. Amplification of JEV in swine often precedes human epidemics (Van Den Hurk et al., 2009). Intervals between pig and human infections are 7–14 days corresponding to virus development in mosquitoes (Impoinvil et al., 2013a). JEV infection occurs in humans, predominantly children and travellers from non-endemic areas who have not developed immunity to the virus. Humans are normally dead-end hosts (Impoinvil et al., 2013a).

JEV is the greatest known cause of epidemic viral encephalitis worldwide. In endemic countries, where adults have acquired immunity through natural infection, approximately 70,000 cases occurred annually resulting in at least 15,000 deaths with 50% of cases in China (Misra and Kalita, 2010; Campbell et al., 2011; Impoinvil et al., 2013a).

A recent multicriteria decision analysis conducted in Australia found JEV, along with rabies, Nipah virus, and Eastern equine encephalitis, to be the highest priority diseases in the swine industry when considering zoonotic criteria alone (Brookes et al., 2014). In regions where the virus exists, several key characteristics influence human infection risk: the density, size, and spatial organisation of rice paddies, swine farms, and human communities (Le Flohic et al., 2013).

### 3.1.1.4. Article 7(a)(iv) The resistance to treatments, including antimicrobial resistance

#### Parameter 1 – Resistant strain to any treatment even at laboratory level

There are currently no specific antiviral therapies for this disease so no resistance to treatments or drugs are described.

### 3.1.1.5. Article 7(a)(v) The persistence of the disease in an animal population or the environment

#### *Animal population*

There are limited data about the duration of the infectious period:

Pigs can produce high viraemia ( $10^6$  SMIC LD50/ml of blood) from 24 hpi lasting 4 days or more. Persistence of RNA of the virus in tonsils of infected pigs have been recently described during, at least, 25 days although there is no evidence for persistence of live virus (Ricklin et al., 2016).

Horses are thought to be dead-end hosts although viraemia of about  $10^{1,2}$  SMIC LD50/0.03 mL of blood can last 2–6 days (Impoinvil et al., 2013b).

Some water fowls, which are asymptomatic carriers, can produce  $10^{3,5}$  SMIC LD50/0.03 mL of blood lasting 3–5 days (Buescher et al., 1959).

More data are needed about the role of bats, snakes, lizards and frogs (OIE, online-b).

#### *Environment*

#### Parameter 4 – Length of survival (dpi) of the agent and/or detection of DNA in selected matrices (soil, water, air) from the environment (scenarios: high and low T)

Seasonal precipitation, humidity, and temperature changes are thought to influence JEV transmission by affecting human agricultural practices and the life cycle of mosquito vectors. Absolute humidity is related to longevity, mating, dispersal, and feeding behaviour of mosquitoes. Temperatures within the range 22–34°C increases mosquito density, decreases larval development time and reduces the extrinsic incubation period of the virus in mosquito vectors, affecting potential JEV transmission (Wang et al., 2014; Tian et al., 2015).

The thermal inactivation point of JEV is 40°C, so the virus could be inactivated by heating for 30 minutes at 56°C. Organic and lipid solvents, common detergents, iodine, phenol iodophors, 70% ethanol, 2% glutaraldehyde, 3–8% formaldehyde or 1% sodium hypochlorite could also be used for it. JEV is labile, sensitive to ultraviolet light, gamma radiation and acidic environments (pH 1–3). It does not survive well in the environment (Wang et al., 2009). At 24°C, the virus, as aerosol, survives 28, 38 and 62 min at relative humidity of 80, 55, and 30%, respectively (Larson et al., 1980).

Fomites are not considered to play a role in the epidemiology so no decontamination precautions are necessary (AHA/AUSVETPLAN, 1998).

### 3.1.1.6. Article 7(a)(vi) The routes and speed of transmission of the disease between animals, and, when relevant, between animals and humans

#### *Routes of transmission*

JEV is transmitted by the bite of an infected mosquito. Several species belonging to *Aedes*, *Anopheles*, *Armigeres*, *Culex* and *Mansonia* are able to carry the virus. *Culex* are the most efficient being *Culex tritaeniorhynchus*, *Culex annulirostris*, *Culex annulus*, *Culex fuscicephala*, *Culex gelidus*, *Culex sitiens* and *Culex vishnu* complex good vectors (Le Flohic et al., 2013). *Mansonia* spp. is also important in India and it has been also detected in midges. *Culex pipiens*, *Culex quinquefasciatus*, *Culex tarsalis* and *Ochlerotatus detritus* are susceptible to JEV infection (Huang et al., 2014). The mosquito species in which JEV was detected occurring in European Union (EU) are listed <https://efsa.maps.arcgis.com/apps/MapJournal/index.html?appid=651eea3fab9a49fb9874d7638870c7cb> (EFSA AHAW Panel, 2017b).

*Cx. tritaeniorhynchus*, the main vector, is able to transmit JEV 5 dpi depending on temperatures. It becomes infectious with low doses of virus ( $10^{1-3.5}$  SMD LD50/0.03 mL of blood. Concentration of virus in saliva could reach  $10^{4.2}$  SMIC-LD50/1 mL (Impoinvil et al., 2013b). They are zoophilic vectors and they usually prefer wading birds, cattle and pigs to humans but they are opportunistic blood feeders and since in some countries pig farming is scarce, some authors suggest the existence of alternative cycles where domesticated birds (mainly chicken and ducks) could serve as amplifiers hosts (Lord et al., 2015).

In addition to natural transmission cycles, attention must also be given to artificial insemination practices in modern swine production. A new route of transmission, vector-free, has been proposed. It

seems that pigs shed virus in oro-nasal secretions and are highly susceptible to oronasal infection (Ricklin et al., 2016). These authors have also found RNA of JEV in tonsils for at least 25 days (Ricklin et al., 2016). This new mechanism and the possible long persistence of the virus in tonsils should be studied in depth in order to ascertain the implications for overwintering and for transmission of the virus. No other routes of transmission have been described.

It seems that year-round maintenance of JEV occurs by overwintering mosquitoes, vertical transmission, poikilothermic vertebrates and/or hibernating bats (Schuh et al., 2013, 2014). Annual reintroduction by migrating birds, bats or wind-borne mosquitoes is also a possibility (Van Den Hurk et al., 2009) although phylogeny studies suggest more local cycles of transmission (Schuh et al., 2014).

#### *Speed of transmission*

As each extrinsic incubation period in mosquitoes ranges from 5–15 days, it can take up to 30 days for the virus to complete its infection process in humans (Impoinvil et al., 2013a).

No transmission rate has been established.

### **3.1.1.7. Article 7(a)(vii) The absence or presence and distribution of the disease in the Union, and, where the disease is not present in the Union, the risk of its introduction into the Union**

#### *Presence and distribution*

JEV is not present in the EU. JEV is endemic in several countries of Asia and the Pacific. Local transmission of JEV has not been detected in Africa, Europe or the Americas.

In endemic areas, cases usually occur sporadically throughout the year although occasional increases could appear during the rainy season. In northern temperate Asian regions, epidemics take place in summer months while in subtropical regions, such as Thailand and Vietnam, may see a combination of epidemic and endemic disease characteristics (Impoinvil et al., 2013a).

Epizootics involving swine appear to be cyclical, consisting of two separate amplification cycles. During the first cycle, roughly 20% of pigs will become infected and develop antibodies within ten days. This is followed by a second cycle, 1–2 weeks later, in which mosquitoes transmit the virus to remaining naïve pigs effectively raising the rate of seroconversion to almost 100%. Clinical cases in humans typically occur following this cycle of amplification in swine (Impoinvil et al., 2013a).

#### *Risk of introduction*

Risk of dispersion of JEV to new areas, including EU, and chances for establishing new endemic foci have been established by Pfeiffer and Dobler (2010) as moderate considering viremic long distance migratory birds as the main mode of dispersal although it can be dispersed through infected mosquitoes or movement of pigs.

Durand et al. (2013) have quantified the risk of introduction by live animal trade into the EU and regarding the availability of suitable vectors, the risk of infection of local vectors and the occurrence of human and equine cases. Neither poultry nor swine were imported during this study from regions where JEV occurred and birds imports from Southeast Asia strongly decreased after 2005 because of influenza bans. Hotspots, or high risk regions, were defined in United Kingdom, Portugal, Italy, Belgium, the Netherlands, Bulgaria, Germany, the Czech Republic, Denmark and Greece. The infectious period in pigs is one to four days or more while birds (asymptomatic carriers) are infectious for 3–5 days (see Section 3.1.1.5).

Travel-associated JE can occur among people of any age but humans are dead-end hosts. For most travellers to Asia, the risk for JE is extremely low but varies based on destination, duration, season and activities. From 1992 through 2008, 21 JE cases among travellers (most of them from the EU) or expatriates from non-endemic countries were reported being most of them short term visitors (Buhl and Lindquist, 2009).

For the importation of horses from countries or zones infected with JE, OIE establishes (OIE, 2016b) that Veterinary Authorities should require the presentation of an international veterinary certificate attesting that the animals:

- 1) showed no clinical sign of Japanese encephalitis on the day of shipment; and

EITHER

- 2) were kept for the 21 days prior to shipment, in an insect-proof quarantine station and were protected from insect vector attack during their transportation from the quarantine station to the place of shipment;

OR

- 3) were vaccinated against Japanese encephalitis not less than 7 days and no more than 12 months prior to shipment.

### 3.1.1.8. Article 7(a)(viii) The existence of diagnostic and disease control tools

#### *Diagnostic tools*

##### Parameter 1 – Existence of diagnostic tools

As for other arboviruses, the period of viraemia is short and the titre is low so PCR and/or viral isolation could be useful only if the sample was taken in acute phases of the disease and cold chain is well preserved. Isolates may sometimes be obtained from cerebrospinal fluid (CSF) or from brain tissue (either at necropsy or post-mortem needle biopsy). Direct detection (and identification) of the virus confirms its presence. Many molecular tests, described in literature and in-house serological diagnostic tests can be used [reviewed in (WHO, 2007; Lambert et al., 2016; OIE, 2016a)].

Detection of immunoglobulin M (IgM) in CSF samples could be also confirmatory of JEV infection although infection by other flaviviruses should be ruled out by epidemiological criteria and/or laboratory discrimination of the presence of antigenically related flaviviruses. Neutralisation of viral growth based-techniques are needed to do that. If no CSF is available and only serum samples are available two samples taken 14 days apart are required to see a four-fold rise in the antibodies titre against JEV. The haemagglutination inhibition test, complement fixation and other techniques can be used but IgM and IgG capture enzyme-linked immunosorbent assays (ELISAs) are the accepted standards for diagnosis of JE. Antibodies begin to appear soon after onset, but only about 70–75% of human patients have IgM antibody in specimens collected up to 4 days after onset. However, all patients will have antibody 7–10 days after onset. After the first 9–10 days of illness, the presence of anti-JEV IgM in the CSF has a sensitivity and specificity of > 95% for CNS infection with the virus (before this, false negatives may occur). The sensitivity for the detection of JE-specific IgM in serum is approximately the same as for CSF.

Previous vaccination can also interfere with interpretation of results so a good clinical history and two paired sera samples and/or CSF for IgM or direct detection are needed (WHO, 2006). To distinguish between antibodies from natural infection and antibodies to inactivated vaccines, ELISA detection of antibody to the non-structural NS1 protein of the virus is utilised (OIE, online-b).

#### *Control tools*

##### Parameter 2 – Existence of control tools

Two main approaches for control of JEV transmission are (1) interrupting contact with the mosquito or (2) using vaccines to prevent disease in infected humans or animals (Impoinvil et al., 2013a).

To **interrupt contact with the mosquito**, environmental management is needed: stabling animals during peak mosquito biting activity in screened barns or with barn fans; intermittent irrigation of crops or rearing pigs away from hosts -human and horses-. Chemical (repellents, such as DEET, applied to individual animals, barn walls and screens) or biological compounds (larvivorous fish, nematodes, bacterial toxins, insect predators and pathogenic fungi) could be used. It has been shown that pigs treated with repellents are 0.23 times as likely to seroconvert as control pigs but these compounds should be used with care (Dutta et al., 2011).

**Vaccination** is applied to horses, pigs and humans. Thanks to horse vaccination in Japan, morbidity dropped to 29.74 cases/105 per year in 1960 to 3.33/105 per year in 1967 (Nakamura, 1972). In Taiwan, a study carried out in 1969 demonstrated that after vaccination with a live attenuated strain of JEV, the total incidence of litter stillbirths in the vaccinated group (1/74) was significantly lower than that in the control group (21/68) (Hsu et al., 1972). Vaccinating pigs is thought to decrease the amplification of the virus protecting human and equine population. However due to the rapid turnover in pigs and the cost of vaccines, vaccination of pigs is not practical and/or sustainable. Human vaccination can reach efficacies up to 98%. WHO recommends that JE vaccination should be integrated into national immunisation schedules in all areas where JE is recognised as a public health priority. Vaccination is also recommended for travellers or migrants to endemic areas with extensive outdoor exposure during the transmission season (WHO/WER, online).

### 3.1.2. Article 7(b) The impact of diseases

#### 3.1.2.1. Article 7(b)(i) The impact of the disease on agricultural and aquaculture production and other parts of the economy

##### *The level of presence of the disease in the Union*

##### Parameter 1 – Number of MSs where the disease is present

JEV is not present in the EU. Recently, sequences from JEV have been found in mosquitoes and birds collected in northern Italy (Platonov et al., 2012; Ravanini et al., 2012). Since the sequences



found are short fragments and no virus could be isolated from these samples, deeper investigations need to be carried out to clarify the possible presence of the virus or a similar one in Europe (Zeller, 2012).

#### *The loss of production due to the disease*

##### Parameter 2 – Proportion of production losses (%) by epidemic/endemic situation

Morbidity rates in horses are as high as 2% during epidemics with mortality being as high as 5%. Mortality in non-immune infected piglets can approach 100% (Impoinvil et al., 2013a).

The economic impact for horses in Asia is not well established.

Some epidemics resulted in pig reproductive losses of 50–70% (OIE, online-b).

### **3.1.2.2. Article 7(b)(ii) The impact of the disease on human health**

#### *Transmissibility between animals and humans*

Although some research about the possibility of oral transmission is needed, the only demonstrated route of transmission of the virus is by the bite of infected mosquitoes and, as previously said, the virus circulates in epidemic or endemic cycles of transmission depending, mainly, on the availability of suitable vectors and reservoirs.

#### *Transmissibility between humans*

See Section 3.1.2.2.

#### *The severity of human forms of the disease*

##### Parameter 5 – Disability-adjusted life year (DALY)

In endemic countries, where adults have acquired immunity through natural infection, JE is primarily a disease of children. Children up to 15 years of age are most affected (75%). The incubation period is 5–15 days. Most JEV infections are mild (fever and headache, backache, myalgia and, mainly in children, nausea, vomiting, anorexia and diffuse abdominal pain) or without apparent symptoms, lasting for a week, but approximately 1 in 250 infections results in severe clinical illness (Solomon and Winter, 2004). Severe disease is characterised by rapid onset of high fever, headache, neck stiffness, change in mental status, disturbances in speech, gait and other motor functions, disorientation, coma, seizures, spastic paralysis and ultimately death. The case-fatality rate can be as high as 30% among those with disease symptoms. The attack rate is low (2 cases/10<sup>5</sup> per year). (Misra and Kalita, 2010; Campbell et al., 2011; Impoinvil et al., 2013a). Of those who survive, 20–30% suffer permanent intellectual, behavioural or neurological problems such as JE Parkinsonian syndrome with mask like facies, tremors, cogwheel rigidity and choreoathetoid movement or paralysis, recurrent seizures or the inability to speak. Children are mainly affected in endemic areas while in non-endemic regions all ages are affected equally. Mortality in the elderly is about 40% (Oya and Kurane, 2007; Misra and Kalita, 2010).

One study in Cambodia has established the cost of US\$ 441 per human case in a country where the gross national income per capita is about US\$ 723 (Touch et al., 2010). On the other hand, a study have shown that cost savings of JE vaccination have reached up to US\$ 72,922 per one prevented case compared to do nothing (Siraprasiri et al., 1997). JEV hospitalisation and care in Cambodia can amount to nearly ten times a farmer's monthly salary and sequelae in survivors must be added (Touch et al., 2010).

Although severely under-reported, 50,000 cases are annually recorded through Asia, with 15,000 deaths (5–35% case fatality rate) and a 75% JE-related disability rate. Estimation of the global burden of JE is over 700,000 DALY (Mathers et al., 2007; WHO, online).

A cost-effectiveness analysis for 14 countries eligible for funding from the Global Vaccine Alliance (GAVI) estimated that, from 2007 to 2021, 193,676 cases, 43,446 deaths, 77,470 cases with sequelae, 6,622,932 DALYs (Siraprasiri et al., 1997).

#### *The availability of effective prevention or medical treatment in humans*

As previously said, no effective treatment is available.

Regarding vaccines, three commercial vaccines have been authorised by the European Medicine Agency (EMA)<sup>1</sup> for use in humans in Europe. Vaccination has almost eliminated the incidence of the

<sup>1</sup> <http://www.ema.europa.eu/ema/>

disease in countries such as Japan, Korea or Taiwan although the effect of other activities such as vector control or alternative agricultural practices cannot be ruled out (Van Den Hurk et al., 2009).

### **3.1.2.3. Article 7(b)(iii) The impact of the disease on animal welfare**

#### Parameter 1 – Severity of clinical signs at case level and related level and duration of impairment

As reported in literature, only equine, swine and human populations are affected by disease caused by this virus.

Subclinical equine infections are common. Usual symptoms are mild illness with transient fever, anorexia, lethargy, congested and jaundiced mucous membrane lasting 2–3 days. Horses can recover or develop encephalitis. The severe encephalitis include high fever, hyperexcitability, aimless wandering, violent and demented behaviour, occasional blindness, profuse sweating and muscle tremors. Death can occur in 1–2 days (Spickler and Roth, 2006).

In pigs, it could cause reproductive diseases (most commonly stillborn or mummified fetuses) but piglets born alive usually do not survive and pregnant sows usually abort. Non-pregnant animals could develop a febrile syndrome but encephalitis have been observed in pigs up to 6 months of age and infertility in boars has also been observed (OIE, online-b).

To avoid infections by JEV an effective measure is to avoid mosquito bites through housing of pigs and horses, using fans and mosquito nets, and animal welfare requirements should be kept in mind for these conditions.

### **3.1.2.4. Article 7(b)(iv) The impact of the disease on biodiversity and the environment**

#### *Biodiversity*

Although JEV can infect many species, it only produces illness in equine and swine populations.

#### *Environment*

#### Parameter 3 – Capacity of the pathogen to persist in the environment and cause mortality in wildlife

The virus cannot persist in the environment outside mosquitoes and vertebrate hosts (AHA/AUSVETPLAN, 1998). Environmental considerations should be directed towards procedures that control insect vectors, including the removal of wastewater in the area that may facilitate breeding of mosquitoes. The non-controlled use of non-approved repellents for vector control could have some effect on the environment however environmental contamination plays no role in the transmission of infection (OIE, 2016b).

### **3.1.3. Article 7(c) Its potential to generate a crisis situation and its potential use in bioterrorism**

JEV is listed in the OIE list of notifiable terrestrial and aquatic animal diseases (OIE, online-a). It is also included in the List of Human and Animal Pathogens and Toxins for Export Control by the Australia group (AG, 2017). It could be classified in the category B viral encephalitis [alphaviruses (e.g. Venezuelan equine encephalitis, eastern equine encephalitis, western equine encephalitis)] of CDC Bioterrorism Agents (CDC, online-b), although it is not considered as select agents are biological agents and toxins that have been determined to have the potential to pose a severe threat to public health and safety, to animal and plant health, or to animal or plant products (CDC, online-a).

### **3.1.4. Article 7(d) The feasibility, availability and effectiveness of the following disease prevention and control measures**

#### **3.1.4.1. Article 7(d)(i) Diagnostic tools and capacities**

#### *Availability*

#### Parameter 1 – Officially/internationally recognised diagnostic tool, OIE certified

Commercial assays for serological detection in human are available in Europe (ELISA Panbio Japanese Encephalitis – Dengue IgM combo, 96 tests PB Cat. No E-JED01C, IFA EUROIMMUN JEV IgG/IgM IIFT Cat. No FI 2663-1005 G/M). A rapid test for the detection of JEV antibodies [Japanese Encephalitis IgG ELISA kit <http://www.rapidtest.com/index.php?i=Japanese-Encephalitis-IgG-ELISA-kit&id=618&cat=17> (Diagnostic Automation/Cortez Diagnostics INC., online)] is also available. Diagnostic tools for detection and identification of JEV were available, the 24 August 2011, in 20 out

34 countries associated to the European Network for Diagnostics of 'Imported' Viral Diseases (ENIVD, online).

#### *Effectiveness*

##### Parameter 2 – Se and Sp of diagnostic test

No specific data about Se and Sp are available.

#### *Feasibility*

##### Parameter 3 – Type of sample matrix to be tested (blood, tissue, etc.)

For the diagnostic of this illness, CSF, serum, blood or tissue samples are suitable for direct detection. Serum samples are needed for serological diagnostic.

#### **3.1.4.2. Article 7(d)(ii) Vaccination**

There are four main types of JE vaccines currently in use: inactivated mouse brain-derived vaccines (Nakayama strain), inactivated Vero cell-derived vaccines (based on attenuated SA14-14-2), live attenuated vaccines (SA14-14-2 strain) and live recombinant vaccines (based on the infectious clone of 17 D Yellow Fever vaccine containing the premembrane and envelope genes of SA14-14-2 virus) (Yun and Lee, 2014). Vaccination of swine can decrease amplification of the virus; however, cost may be prohibitive and effectiveness low because of maternal antibodies.

Over the past years, the live attenuated SA14-14-2 vaccine manufactured in China has become the most widely used vaccine in endemic countries, and it was prequalified by WHO in October 2013. Cell-culture based inactivated vaccines and the live recombinant vaccine based on the yellow fever vaccine strain have also been licensed and WHO prequalified. Inactivated Vero cell-derived vaccines were licensed in the USA (for people aged 17 years), in Europe – Austria, Belgium, the Czech Republic, Denmark, Finland, France, Germany, Hungary, Ireland, Italy, the Netherlands, Poland, Portugal, Slovak Republic, Spain, Sweden and the UK, outside of the EU, Canada, Switzerland and Australia.

In Europe, Ixiaro vaccine is approved for adults and children aged 2 months and older and it could be produced in excess of one million doses per year.<sup>2</sup>

A marked decline in the incidence of clinical disease in horses has been observed at least in Japan, Goto, Singapore and China after the implementation of vaccination (Ellis et al., 2000).

#### **3.1.4.3. Article 7(d)(iii) Medical treatments**

There is no specific antiviral treatment for JE; therapy consists of supportive care and management of complications. Only two clinical trials have been described with no success by using interferon alpha-2a (Gould et al., 2008) or ribavirin (Kumar et al., 2009).

#### **3.1.4.4. Article 7(d)(iv) Biosecurity measures**

Ideally, all activities involving handling of infectious and potentially infectious diagnostic materials should take place under Biosafety Level 2 (BSL-2) conditions, and all activities involving the amplification of virus, either in vitro or in vivo, should take place under BSL-3 conditions (WHO, 2007).

Laboratory-acquired JEV infection has been reported in humans [22 cases reported up to 1980 (Anonymous, 1980)] and work with the virus is restricted to Biosafety Level 3 (BSL-3) facilities and practices. Transmission can occur through needle stick and potentially at mucosal surfaces if exposed to high concentrations of aerosolised virus (Fischer et al., 2010). Vaccination of personnel working directly and regularly with JEV is recommended.

Regarding biosecurity measures defined as the implementation of measures that reduce the risk of disease agents being introduced and spread, segregation, cleaning and disinfection are the main measures in pig farming (FAO/WHO/World Bank, 2010). General rules are available but no specific biosecurity measures in relation to JEV are available.

#### **3.1.4.5. Article 7(d)(v) Restrictions on the movement of animals and products**

Currently, the EU legislation does not lay down specific measures for JEV outbreak control and neither are specific trade restrictions in place to prevent import of JEV through movements of swine, i.e. through testing of the imported swine for JEV.

<sup>2</sup> <http://www.valneva.com/en/products/11>

In areas where this disease is not endemic infected animals may be euthanised (OIE, 2016a). The OIE's Terrestrial Animal Health Code recommends preventive measures for importing horses from countries or zones infected with JEV, but no recommendations currently exist for importation of swine (OIE, 2016b).

The benefit gained by placing restrictions on the movement of horses, cattle, sheep and goats, which are considered dead-end hosts, from infected premises or areas seem to be limited (AHA/AUSVETPLAN, 1998). However, movement of pigs, the amplifier hosts, requires careful consideration and control areas around infected premises should be established. Movements of pigs out of defined control areas needs to be restricted to the extent that pigs for restocking or breeding purposes would only be moved under permit conditions minimising likely spread of infection to new populations (AHA/AUSVETPLAN, 1998). Pigs for slaughter on recently-infected premises would be unrestricted for slaughter within the control area and movements out of the control area could be permitted when reducing the likelihood of mosquitoes spreading infection at new sites. For horses moving into the control area, vaccination is recommended.

#### **3.1.4.6. Article 7(d)(vi) Killing of animals**

No specific general guidelines about killing of animals when JEV is circulating have been found. In some countries like Thailand, pigs must be killed after a JEV outbreak (Coker et al., 2011) although destruction of infected animals will not assist disease control but sick animals (mainly horses) may need destroyed on welfare grounds (AHA/AUSVETPLAN, 1998).

Due to the time taken to establish a diagnosis, continuing virus transmission by insects, the wide range of hosts and the lack of clinical signs in most infected animals, control by slaughtering exposed animals is inappropriate (AHA/AUSVETPLAN, 1998).

#### **3.1.4.7. Article 7(d)(vii) Disposal of carcasses and other relevant animal by-products**

There are no special requirements for the disposal of carcasses from infected premises (AHA/AUSVETPLAN, 1998).

Treatment of animal products and by-products represent negligible risk in the spread of the disease, and treatment of such products is not necessary (AHA/AUSVETPLAN, 1998).

### **3.1.5. Article 7(e) The impact of disease prevention and control measures**

#### **3.1.5.1. Article 7(e)(i) The direct and indirect costs for the affected sectors and the economy as a whole**

JEV hospitalisation and care in Cambodia has been estimated close to US\$ 441, and this can amount to nearly ten times a farmer's monthly salary and sequelae in survivors must be added (Touch et al., 2010) and cost savings of JE vaccination have reached up to US\$ 72,922 per one prevented case compared to do nothing (Siraprapasiri et al., 1997). In a cost-effectiveness analysis for 14 countries eligible for funding from the GAVI Alliance estimated that US\$ 19 million in acute hospitalisation costs could be avoided by immunisation with the live, attenuated SA 14-14-2 JE vaccine through campaigns and implementation of routine immunisation programs (Siraprapasiri et al., 1997). Costs of immunisation in these 14 countries (India, Nepal, Sri Lanka, Bangladesh, Cambodia, Democratic People's Republic of Korea, Indonesia, Papua New Guinea, Timor Leste, Vietnam, Bhutan, Lao PDR, Myanmar and Pakistan) were estimated in a plan for the control of JEV by 2015 reaching US\$ 338 million. If other countries (Australia – Torres Strait Islands, Brunei Darussalam, China, Japan, Republic of Korea, Malaysia, Philippines, Thailand) are added to this strategy, we should add US\$ 2,583 million to these costs (Anonymous, 2015).

Analysis of economic costs carried out in USA for West Nile in an epidemic that resulted in 569 horse cases with a 22% mortality have associated economic losses of US\$ 1.5 million (781,203 spent on medical costs and 802,790 due to inability to use affected horses because of the disease (Ndiva Mongoh et al., 2008).

Regarding animal costs, there are many countries like Thailand where veterinary authorities are obliged by law to cull pigs after a JEV outbreak (Coker et al., 2011), however legislation depends on each country.

### 3.1.5.2. Article 7(e)(ii) The societal acceptance of disease prevention and control measures

No information about the costs for affected sectors and the types of prevention and control measures that this may entail issues about societal acceptance has been found, so this remains a gap in available knowledge.

### 3.1.5.3. Article 7(e)(iii) The welfare of affected subpopulations of kept and wild animals

One of the control activities is housing of animals and this should be carried out according to legislation about the welfare of kept animals.

The use of insecticides and repellents needs to be carried out following strict regulations and avoiding detrimental effects on animals.

However, no specific guidelines for prevention and control measures of JEV regarding the welfare of animals are available constituting a gap of knowledge.

### 3.1.5.4. Article 7(e)(iv) The environment and biodiversity

As previously said, the use of insecticides and repellents needs to be carried out following strict regulations and avoiding detrimental effects on biodiversity but since no specific guidelines for prevention and control measures of JEV regarding this point are available, it constitutes a gap of knowledge.

## 3.2. Assessment according to Article 5 criteria

This section presents the results of the expert judgement on the criteria of Article 5 of the AHL about JE (Table 1). The expert judgement was based on Individual and Collective Behavioural Aggregation (ICBA) approach described in detail in the opinion on the methodology (EFSA AHAW Panel, 2017a). Experts have been provided with information of the disease fact-sheet mapped into Article 5 criteria (see supporting information, Annex A), based on that the experts indicate their Y/N or 'na' judgement on each criterion of Article 5, and the reasoning supporting their judgement.

The minimum number of judges in the judgement was 12. The expert judgement was conducted as described in the methodological opinion (EFSA AHAW Panel, 2017a). For details on the interpretation of the questions see Appendix B of the methodological opinion (EFSA AHAW Panel, 2017a).

**Table 1:** Outcome of the expert judgement on the Article 5 criteria for Japanese encephalitis

| <b>Criteria to be met by the disease:</b>   |  | <b>Final outcome</b> |
|---|--|----------------------|
| According to AHL, a disease shall be included in the list referred to in point (b) of paragraph 1 of Article 5 if it has been assessed in accordance with Article 7 and meets all of the following criteria |  |                      |
| A(i)  | The disease is transmissible   | Y                    |
| A(ii)   | Animal species are either susceptible to the disease or vectors and reservoirs thereof exist in the Union  | Y                    |
| A(iii)  | The disease causes negative effects on animal health or poses a risk to public health due to its zoonotic character  | Y                    |
| A(iv)   | Diagnostic tools are available for the disease   | Y                    |
| A(v)  | Risk-mitigating measures and, where relevant, surveillance of the disease are effective and proportionate to the risks posed by the disease in the Union                               | Y                    |
| <b>At least one criterion to be met by the disease:</b>   |  |                      |
| In addition to the criteria set out above at points A(i)–A(v), the disease needs to fulfil at least one of the following criteria   |  |                      |
| B(i)  | The disease causes or could cause significant negative effects in the Union on animal health, or poses or could pose a significant risk to public health due to its zoonotic character | Y                    |
| B(ii)   | The disease agent has developed resistance to treatments and poses a significant danger to public and/or animal health in the Union  | na                   |
| B(iii)  | The disease causes or could cause a significant negative economic impact affecting agriculture or aquaculture production in the Union  | Y                    |
| B(iv)   | The disease has the potential to generate a crisis or the disease agent could be used for the purpose of bioterrorism  | Y                    |
| B(v)  | The disease has or could have a significant negative impact on the environment, including biodiversity, of the Union   | N                    |

Colour code: green = consensus (Yes/No); red = not applicable (na), i.e. insufficient evidence or not relevant to judge.

### 3.2.1. Outcome of the assessment of Japanese encephalitis according to criteria of Article 5(3) of the AHL on its eligibility to be listed

As from the legal text of the AHL, a disease is considered eligible to be listed as laid down in Article 5 if it fulfils all criteria of the first set from A(i) to A(v) and at least one of the second set of criteria from B(i) to B(v). According to the assessment methodology (EFSA AHAW Panel, 2017a), a criterion is considered fulfilled when the outcome is 'Yes'. According to the results shown in Table 1, JE is considered to be eligible to be listed as laid down in Article 5 of the AHL.

### 3.3. Assessment according to Article 9 criteria

This section presents the results of the expert judgement on the criteria of Annex IV referring to categories as in Article 9 of the AHL about Japanese encephalitis (Tables 2–6). The expert judgement was based on ICBA approach described in detail in the opinion on the methodology. Experts have been provided with information of the disease fact-sheet mapped into Article 9 criteria (see supporting information, Annex A), based on that the experts indicate their Y/N or 'na' judgement on each criterion of Article 9, and the reasoning supporting their judgement.

The minimum number of judges in the judgement was 12. The expert judgement was conducted as described in the methodological opinion (EFSA AHAW Panel, 2017a). For details on the interpretation of the questions see Appendix B of the methodological opinion (EFSA AHAW Panel, 2017a).

**Table 2:** Outcome of the expert judgement related to the criteria of Section 1 of Annex IV (category A of Article 9) for Japanese encephalitis

| <b>Criteria to be met by the disease:</b>   |   | <b>Final outcome</b> |
|---|---|----------------------|
| The disease needs to fulfil all of the following criteria   |   |                      |
| 1   | The disease is not present in the territory of the Union OR present only in exceptional cases (irregular introductions) OR present in only in a very limited part of the territory of the Union                   | Y                    |
| 2.1   | The disease is highly transmissible   | N                    |
| 2.2   | There be possibilities of airborne or waterborne or vector-borne spread   | Y                    |
| 2.3   | The disease affects multiple species of kept and wild animals OR single species of kept animals of economic importance  | Y                    |
| 2.4   | The disease may result in high morbidity and significant mortality rates  | NC                   |
| <b>At least one criterion to be met by the disease:</b>   |   |                      |
| In addition to the criteria set out above at points 1–2.4, the disease needs to fulfil at least one of the following criteria |   |                      |
| 3   | The disease has a zoonotic potential with significant consequences on public health, including epidemic or pandemic potential OR possible significant threats to food safety                                      | N                    |
| 4   | The disease has a significant impact on the economy of the Union, causing substantial costs, mainly related to its direct impact on the health and productivity of animals  | Y                    |
| 5(a)  | The disease has a significant impact on society, with in particular an impact on labour markets   | N                    |
| 5(b)  | The disease has a significant impact on animal welfare, by causing suffering of large numbers of animals  | NC                   |
| 5(c)  | The disease has a significant impact on the environment, due to the direct impact of the disease OR due to the measures taken to control it   | NC                   |
| 5(d)  | The disease has a significant impact on a long-term effect on biodiversity or the protection of endangered species or breeds, including the possible disappearance or long-term damage to those species or breeds | N                    |

Colour code: green = consensus (Yes/No); yellow = no consensus (NC).

**Table 3:** Outcome of the expert judgement related to the criteria of Section 2 of Annex IV (category B of Article 9) for Japanese encephalitis

| <b>Criteria to be met by the disease:</b>   |   | <b>Final outcome</b> |
|---|---|----------------------|
| The disease needs to fulfil all of the following criteria   |   |                      |
| 1   | The disease is present in the whole OR part of the Union territory with an endemic character AND (at the same time) several Member States or zones of the Union are free of the disease                           | N                    |
| 2.1   | The disease is moderately to highly transmissible   | Y                    |
| 2.2   | There be possibilities of airborne or waterborne or vector-borne spread   | Y                    |
| 2.3   | The disease affects single or multiple species  | Y                    |
| 2.4   | The disease may result in high morbidity with in general low mortality  | NC                   |
| <b>At least one criterion to be met by the disease:</b>   |   |                      |
| In addition to the criteria set out above at points 1–2.4, the disease needs to fulfil at least one of the following criteria |   |                      |
| 3   | The disease has a zoonotic potential with significant consequences on public health, including epidemic potential OR possible significant threats to food safety  | Y                    |
| 4   | The disease has a significant impact on the economy of the Union, causing substantial costs, mainly related to its direct impact on the health and productivity of animals  | Y                    |
| 5(a)  | The disease has a significant impact on society, with in particular an impact on labour markets   | N                    |
| 5(b)  | The disease has a significant impact on animal welfare, by causing suffering of large numbers of animals  | NC                   |
| 5(c)  | The disease has a significant impact on the environment, due to the direct impact of the disease OR due to the measures taken to control it   | NC                   |
| 5(d)  | The disease has a significant impact on a long-term effect on biodiversity or the protection of endangered species or breeds, including the possible disappearance or long-term damage to those species or breeds | N                    |

Colour code: green = consensus (Yes/No); yellow = no consensus (NC).

**Table 4:** Outcome of the expert judgement related to the criteria of Section 3 of Annex IV (category C of Article 9) for Japanese encephalitis

| <b>Criteria to be met by the disease:</b>   |   | <b>Final outcome</b> |
|---|---|----------------------|
| The disease needs to fulfil all of the following criteria   |   |                      |
| 1   | The disease is present in the whole OR part of the Union territory with an endemic character  | N                    |
| 2.1   | The disease is moderately to highly transmissible   | Y                    |
| 2.2   | The disease is transmitted mainly by direct or indirect transmission  | Y                    |
| 2.3   | The disease affects single or multiple species  | Y                    |
| 2.4   | The disease usually does not result in high morbidity and has negligible or no mortality AND often the most observed effect of the disease is production loss   | N                    |
| <b>At least one criterion to be met by the disease:</b>   |   |                      |
| In addition to the criteria set out above at points 1–2.4, the disease needs to fulfil at least one of the following criteria |   |                      |
| 3   | The disease has a zoonotic potential with significant consequences on public health, or possible significant threats to food safety   | Y                    |
| 4   | The disease has a significant impact on the economy of parts of the Union, mainly related to its direct impact on certain types of animal production systems  | N                    |
| 5(a)  | The disease has a significant impact on society, with in particular an impact on labour markets   | N                    |
| 5(b)  | The disease has a significant impact on animal welfare, by causing suffering of large numbers of animals  | NC                   |
| 5(c)  | The disease has a significant impact on the environment, due to the direct impact of the disease OR due to the measures taken to control it   | NC                   |
| 5(d)  | The disease has a significant impact on a long-term effect on biodiversity or the protection of endangered species or breeds, including the possible disappearance or long-term damage to those species or breeds | N                    |

Colour code: green = consensus (Yes/No); yellow = no consensus (NC).

**Table 5:** Outcome of the expert judgement related to the criteria of Section 4 of Annex IV (category D of Article 9) for Japanese encephalitis

| <b>Criteria to be met by the disease:</b><br>The disease needs to fulfil all of the following criteria |  | <b>Final outcome</b> |
|--|--|----------------------|
| D  | The risk posed by the disease in question can be effectively and proportionately mitigated by measures concerning movements of animals and products in order to prevent or limit its occurrence and spread | N                    |
| Criteria of Sections 1, 2, 3 or 5 of Annex IV of AHL   |  | Y                    |

Colour code: green = consensus (Yes/No).

**Table 6:** Outcome of the expert judgement related to the criteria of Section 5 of Annex IV (category E of Article 9) for Japanese encephalitis

| <b>Diseases in category E need to fulfil criteria of Sections 1, 2 or 3 of Annex IV of AHL and/or the following:</b> |  | <b>Final outcome</b> |
|--|--|----------------------|
| E  | Surveillance of the disease is necessary for reasons relating to animal health, animal welfare, human health, the economy, society or the environment<br>(If a disease fulfils the criteria as in Article 5, thus being eligible to be listed, consequently category E would apply.) | Y                    |

Colour code: green = consensus (Yes/No).

### 3.3.1. Non-consensus questions

This section displays the assessment related to each criterion of Annex IV referring to the categories of Article 9 of the AHL where no consensus was achieved in form of tables (Tables 7–9). The proportion of Y, N or 'na' answers are reported, followed by the list of different supporting views for each answer.

**Table 7:** Outcome of the expert judgement related to criterion 2.4 of Article 9

| <b>Question</b>   | <b>Final outcome</b> | <b>Response</b> |              |               |
|---|----------------------|-----------------|--------------|---------------|
|   |                      | <b>Y (%)</b>    | <b>N (%)</b> | <b>na (%)</b> |
| 2.4(cat.A) The disease may result in high morbidity and significant mortality rates | NC                   | 25              | 0            | 0             |
| 2.4(cat.B) The disease may result in high morbidity with in general low mortality   | NC                   | 75              |              |               |

NC: non-consensus; number of judges: 12.

#### Reasoning supporting the judgement

Supporting Yes for 2.4 (cat.A):

- High morbidity and significant mortality rates, in horses and piglets, have been reported in situations where infection is first introduced into naive, non-immune populations.

Supporting Yes for 2.4 (cat.B):

- Mortality is generally low, but can be higher in naive and non-immune animals.

**Table 8:** Outcome of the expert judgement related to criterion 5(b) of Article 9

| <b>Question</b>   | <b>Final outcome</b> | <b>Response</b> |              |               |
|---|----------------------|-----------------|--------------|---------------|
|   |                      | <b>Y (%)</b>    | <b>N (%)</b> | <b>na (%)</b> |
| 5(b) The disease has a significant impact on animal welfare, by causing suffering of large numbers of animals | NC                   | 83              | 17           | 0             |

NC: non-consensus; number of judges: 12.



### Reasoning supporting the judgement

Supporting Yes:

- There could be an impact, particularly in horses, if JE was introduced in the EU.
- Abortion is a possible outcome and it is a welfare issue.
- There could be an impact given that high mortality is described in non-immune pigs.
- When JE first entered Australia, mortality in naïve population of up to 100% was reported.

Supporting No:

- The most common outcome of JEV infection in pigs are stillborn mummified piglets, which is not linked to animal suffering.
- Encephalitis has been observed, but it is not very common and clinical signs last 2-3 days only.
- Clinical signs are generally mild and few animals show severe clinical signs.

**Table 9:** Outcome of the expert judgement related to criterion 5(c) of Article 9

| Question   | Final outcome | Response |       |        |
|--|---------------|----------|-------|--------|
|  |               | Y (%)    | N (%) | na (%) |
| 5(c) The disease has a significant impact on the environment, due to the direct impact of the disease OR due to the measures taken to control it | NC            | 0        | 33    | 67     |

NC: non-consensus; number of judges: 12.

### Reasoning supporting the judgement

Supporting No:

- Vaccination has been proven to be an effective tool to eradicate the disease, thus there is no urgent need of applying vector control measures in these cases.

Supporting na:

- No data are available on the current or potential effect of vector control measures (e.g. insecticides), and no persistence in the environment is proven. The impact on species that may be indicators of environmental pollution, like bees, is not known.
- It is not known which species can transmit the disease in addition to the ones already known, thus it is not clear which spots have to be treated. The possible vectors for JE in the EU should be investigated.

### **3.3.2. Outcome of the assessment of criteria in Annex IV for Japanese encephalitis for the purpose of categorisation as in Article 9 of the AHL**

As from the legal text of the AHL, a disease is considered fitting in a certain category (A, B, C, D or E corresponding to point (a) to point (e) of Article 9(1) of the AHL) if it is eligible to be listed for Union intervention as laid down in Article 5(3) and fulfils all criteria of the first set from 1 to 2.4 and at least one of the second set of criteria from 3 to 5(d) as shown in Tables 2–6. According to the assessment methodology (EFSA AHAW Panel, 2017a), a criterion is considered fulfilled when the outcome is 'Yes'.

A description of the outcome of the assessment of criteria in Annex IV for JE for the purpose of categorisation as in Article 9 of the AHL is presented in Table 10.

**Table 10:** Outcome of the assessment of criteria in Annex IV for Japanese encephalitis for the purpose of categorisation as in Article 9 of the AHL

| Category | Article 9 criteria        |                  |                        |                  |                         |                    |                   |                   |                          |                       |                        |
|----------|---------------------------|------------------|------------------------|------------------|-------------------------|--------------------|-------------------|-------------------|--------------------------|-----------------------|------------------------|
|          | 1° set of criteria        |                  |                        |                  |                         | 2° set of criteria |                   |                   |                          |                       |                        |
|          | 1                         | 2.1              | 2.2                    | 2.3              | 2.4                     | 3                  | 4                 | 5a                | 5b                       | 5c                    | 5d                     |
|          | Geographical distribution | Transmissibility | Routes of transmission | Multiple species | Morbidity and mortality | Zoonotic potential | Impact on economy | Impact on society | Impact on animal welfare | Impact on environment | Impact on biodiversity |
| A        | Y                         | N                | Y                      | Y                | NC                      | N                  | Y                 | N                 | NC                       | NC                    | N                      |
| B        | N                         | Y                | Y                      | Y                | NC                      | Y                  | Y                 | N                 | NC                       | NC                    | N                      |
| C        | N                         | Y                | Y                      | Y                | N                       | Y                  | N                 | N                 | NC                       | NC                    | N                      |
| D        |                           |                  |                        |                  |                         | N                  |                   |                   |                          |                       |                        |
| E        |                           |                  |                        |                  |                         | Y                  |                   |                   |                          |                       |                        |

According to the assessment here performed, JE complies with the following criteria of the Sections 1 to 5 of Annex IV of the AHL for the application of the disease prevention and control rules referred to in points (a) to (e) of Article 9(1):

- 1) To be assigned to category A, a disease needs to comply with all criteria of the first set (1, 2.1–2.4) and according to the assessment JE complies with criteria 1, 2.2 and 2.3, but not with criterion 2.1 and the assessment is inconclusive on compliance with criterion 2.4. To be eligible for category A, a disease needs to comply additionally with one of the criteria of the second set (3, 4, 5a–d) and JE complies with criterion 4, but not with criteria 3, 5a and 5d and the assessment is inconclusive on compliance with criteria 5b and 5c.
- 2) To be assigned to category B, a disease needs to comply with all criteria of the first set (1, 2.1–2.4) and according to the assessment JE complies with criteria 2.1, 2.2 and 2.3, but not with criterion 1 and the assessment is inconclusive on compliance with criterion 2.4. To be eligible for category B, a disease needs to comply additionally with one of the criteria of the second set (3, 4, 5a–d) and JE complies with criteria 3 and 4, but not with criteria 5a and 5d and the assessment is inconclusive on compliance with criteria 5b and 5c.
- 3) To be assigned to category C, a disease needs to comply with all criteria of the first set (1, 2.1–2.4) and according to the assessment JE complies with criteria 2.1, 2.2 and 2.3, but not with criteria 1 and 2.4. To be eligible for category C, a disease needs to comply additionally with one of the criteria of the second set (3, 4, 5a–d) and JE complies with criterion 3, but not with criteria 4, 5a and 5d and the assessment is inconclusive on compliance with criteria 5b and 5c.
- 4) To be assigned to category D, a disease needs to comply with criteria of Sections 1, 2, 3 or 5 of Annex IV of the AHL, with which JE complies, and with the specific criterion D of Section 4, with which JE does not comply.
- 5) To be assigned to category E, a disease needs to comply with criteria of Sections 1, 2 or 3 of Annex IV of the AHL and/or the surveillance of the disease is necessary for reasons relating to animal health, animal welfare, human health, the economy, society or the environment. The latter is applicable if a disease fulfils the criteria as in Article 5, with which JE complies.

### 3.4. Assessment of Article 8

This section presents the results of the assessment on the criteria of Article 8(3) of the AHL about JE. The Article 8(3) criteria are about animal species to be listed, as it reads below:

'3. Animal species or groups of animal species shall be added to this list if they are affected or if they pose a risk for the spread of a specific listed disease because:

- a) they are susceptible for a specific listed disease or scientific evidence indicates that such susceptibility is likely; or

- b) they are vector species or reservoirs for that disease, or scientific evidence indicates that such role is likely’.

For this reason the assessment on Article 8 criteria is based on the evidence as extrapolated from the relevant criteria of Article 7, i.e. the ones related to susceptible and reservoir species or routes of transmission, which cover also possible role of biological or mechanical vectors.<sup>3</sup> According to the mapping, as presented in Table 5, Section 3.2 of the scientific opinion on the ad hoc methodology (EFSA AHAW Panel, 2017a), the animal species to be listed for JE according to the criteria of Article 8(3) of the AHL are as displayed in Table 11.

**Table 11:** Main animal species to be listed for Japanese encephalitis according to criteria of Article 8 (source: data reported in Sections 3.1.1.1 and 3.1.1.6)

|             | Class         | Order                     | Family        | Genus/Species  |
|-------------|---------------|---------------------------|---------------|--|
| Susceptible | Aves          | Waterfowl (not specified) |               |  |
|             |               | Pelecaniformes            | Ardeidae      | <i>Egretta garzetta</i> , <i>Nycticorax nycticorax</i>   |
|             |               | Galliformes               | Phasianidae   | <i>Gallus gallus</i>   |
|             | Mammalia      | Artiodactyla              | Suidae        | <i>Sus scrofa</i>  |
|             |               |                           | Bovidae       | <i>Bos taurus</i> , <i>Ovis aries</i> , <i>Capra aegagrus</i>  |
|             |               | Perissodactyla            | Equidae       | <i>Equus caballus</i>  |
|             |               | Chiroptera                | Not specified |  |
|             |               | Primates                  | Hominidae     | <i>Homo sapiens</i>  |
|             |               | Carnivora                 | Canidae       | <i>Canis lupus</i>   |
|             |               |                           | Procyonidae   | <i>Procyon lotor</i>   |
| Rodentia    | Not specified |                           |               |  |
| Reptilia    | Not specified |                           |               |  |
| Reservoir   | Aves          | Waterfowl (not specified) |               |  |
| Vectors     | Insecta       | Diptera                   | Culicidae     | Several species belonging to <i>Aedes</i> , <i>Anopheles</i> , <i>Armigeres</i> , <i>Culex</i> and <i>Mansonia</i> genera* |

\*: The species occurring in EU are listed in <https://efsa.maps.arcgis.com/apps/MapJournal/index.html?appid=651eea3fab9a49fb9874d7638870c7cb> (EFSA AHAW Panel, 2017b).

The areas where the available information for carrying out the assessment was not considered sufficient (criteria where ‘na’ answers were provided) are about the host and vector species that can transmit the disease in the EU, which should be therefore investigated.

#### 4. Conclusions

**TOR 1:** for each of those diseases an assessment, following the criteria laid down in Article 7 of the AHL, on its eligibility of being listed for Union intervention as laid down in Article 5(3) of the AHL;

- According to the assessment here performed, Japanese encephalitis complies with all criteria of the first set and with three criteria of the second set and therefore can be considered eligible to be listed for Union intervention as laid down in Article 5(3) of the AHL.

**TOR 2a:** for each of the diseases which was found eligible to be listed for Union intervention, an assessment of its compliance with each of the criteria in Annex IV to the AHL for the purpose of categorisation of diseases in accordance with Article 9 of the AHL;

- According to the assessment here performed, Japanese encephalitis meets the criteria as in Section 5 of Annex IV of the AHL, for the application of the disease prevention and control rules referred to in point (e) of Article 9(1) of the AHL.

<sup>3</sup> A vector is a living organism that transmits an infectious agent from an infected animal to a human or another animal. Vectors are frequently arthropods. Biological vectors may carry pathogens that can multiply within their bodies and be delivered to new hosts, usually by biting. In mechanical vectors the pathogens do not multiply within the vector, which usually remains infected for shorter time than in biological vectors.

**TOR 2b:** for each of the diseases which was found eligible to be listed for Union intervention, a list of animal species that should be considered candidates for listing in accordance with Article 8 of the AHL.

- According to the assessment here performed, the animal species that can be considered to be listed for Japanese encephalitis according to Article 8(3) of the AHL are mainly waterfowl, pigs and equines as susceptible and waterfowl as reservoir species, as reported in Table 11 in Section 3.4 of the present document.

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## Abbreviations

|      |   |
|------|---|
| AHAW | EFSA Panel on Animal Health and Welfare |
| AHL  | Animal Health Law                       |

|           |   |
|-----------|---|
| BSL       | Biosafety Level                                   |
| CSF       | cerebrospinal fluid                               |
| DALY      | disability-adjusted life year                     |
| ELISA     | enzyme-linked immunosorbent assay                 |
| GAVI      | Global Vaccine Alliance                           |
| hpi       | hours post-infection                              |
| ICBA      | Individual and Collective Behavioural Aggregation |
| IgG       | immunoglobulin G                                  |
| IgM       | immunoglobulin M                                  |
| JEV       | Japanese encephalitis virus                       |
| JP        | Japanese encephalitis                             |
| OIE       | World Organisation for Animal Health              |
| RNA       | ribonucleic acid                                  |
| SMIC LD50 | suckling mouse intracerebral lethal dose 50%      |
| WHO       | World Health Organization                         |