Institution: Royal Veterinary College (RVC)

Unit of Assessment: A 6 Agriculture, Veterinary and Food Science

Title of case study: Addressing mass mortality of saiga antelopes: informing global peste des petits ruminants disease control planning and influencing legal and regulatory change

Period when the underpinning research was undertaken: 2011 – 2020

Details of staff conducting the underpinning research from the submitting unit:

Name(s):	Role(s) (e.g. job title):	Period(s) employed by submitting HEI:
Richard Kock	Professor of Wildlife Health and Emerging Disease	04/01/2011 - present

Period when the claimed impact occurred: 01/08/13 – 31/12/20

Is this case study continued from a case study submitted in 2014? N

1. Summary of the impact (indicative maximum 100 words)

RVC research into saiga deaths in Kazakhstan and Mongolia highlighted the previously unknown impact on, and role of wildlife in, the epidemiology of peste des petits ruminants (PPR) and influenced national disease control strategies. It led to changes in Animal Health Law in Mongolia and prompted the Food and Agriculture Organisation (FAO)/World Organisation for Animal Health (OIE) to publish Guidelines for the Control and Prevention of PPR in Wildlife populations, ahead of the forthcoming phase of its PPR global eradication plan. The work has driven regulatory changes in international movement of biological samples, facilitating international investigations into disease outbreaks for all terrestrial and maritime species. Furthermore, it has influenced international classification of the iconic saiga affecting trade so allowing populations to recover following mass mortality events.

2. Underpinning research (indicative maximum 500 words)

Longitudinal studies of saiga calving and mortality set up by RVC's Professor Richard Kock in 2011 have improved understanding of health status and disease threats [1]. The research established a baseline on endemic infection by viruses, bacteria and parasites. This baseline facilitated research examining the transboundary spread of PPR virus into livestock and wildlife in Kazakhstan that affected unvaccinated youngstock put out to summer pasture, highlighted the importance of monitoring wildlife, use of buffer zone vaccination of livestock adjacent to saiga populations, and tighter control of livestock movement and import across borders [2]. This publication noted danger to susceptible wildlife, including saiga, and was published at a time when the cause of a 2015 mass mortality event (MME) was still under investigation. The 2015 MME killed >200,000 saiga (representing 90% of the Central Kazakhstan population and 60% of total worldwide) so represented a significant threat to the species (see below). At that time, the stressor effect of PPR virus infection was considered a possible trigger factor.

This predicted risk was borne out by a subsequent PPR outbreak in Mongolian livestock in 2017, which spilled over into and killed approximately 85% of the only global population of the subspecies of saiga (*Saiga tatarica mongolica)* [3]. This work also highlighted the spill-over of PPR into other wildlife, including Ibex. Kock's field-based research, undertaken jointly in collaboration with the FAO; Wildlife Conservation Society (WCS) and the Veterinary Authorities in Mongolia and in partnership with the Pirbright Institute, supported the definitive diagnosis of PPR in saiga (and other wildlife species) as the cause of the Mongolian MME and a contributor to ongoing deaths through debilitation over the coming year.

The fact that Professor Kock had established strong relationships with the government scientific and veterinary authorities in Kazakhstan prior to the 2015 MME helped ensure a prompt response funded through a Natural Environment Research Council (NERC) emergency grant. Standard operating procedures (SOPs) introduced in 2012 [4] enabled confirmation of the proximate cause of the 2015 MME as haemorrhagic septicaemia (HS) from infection with *Pasteurella multocida* [5, 6, 7] and ruled out PPR as the cause *in this instance*. The research (disease outbreak investigation) undertaken in partnership with national and international groups

highlighted the regulations that hampered rapid disease investigations into mass mortality in endangered wildlife species.

3. References to the research (indicative maximum of six references)

1. Orynbayev MB, **Beauvais W**, Sansyzbay AR, Rystaeva RA, Sultankulova KT, Kerimbaev AA, Kospanova MN, & **Kock RA** (2016) Seroprevalence of infectious diseases in saiga antelope (*Saiga tatarica tatarica*) in Kazakhstan 2012-2014. *Preventive Veterinary Medicine,* 127, 100–104. https://doi.org/10.1016/j.prevetmed.2016.03.016
2. **Kock RA**, Orynbayev MB, Sultankulova KT, Strochkov VM, Omarova, ZD, Shalgynbayev EK, Rametov NM, Sansyzbay AR, & Parida S (2015) Detection and Genetic Characterization of Lineage IV Peste Des Petits Ruminant Virus in Kazakhstan. *Transboundary and Emerging Diseases*, 62(5), 470–479. https://doi.org/10.1111/tbed.12398
3. Pruvot M, Fine AE, Hollinger C, Strindberg S, Damdinjav B, Buuveibaatar B, Chimeddorj B, Bayandonoi G, Khishgee B, Sandag B, Narmandakh J, Jargalsaikhan T, Bataa B, McAloose D, Shatar M, Basan G, Mahapatra M, Selvaraj M, Parida S, Njeumi F, **Kock R**, Shiilegdamba E (2020) Outbreak of Peste des Petits Ruminants among Critically Endangered Mongolian Saiga and Other Wild Ungulates, Mongolia, 2016-2017. *Emerging Infectious Diseases*, 26(1), 51–62. https://doi.org/10.3201/eid2601.181998
4. **Kock RA**, **Rycroft A**, Usenbayev A, Grachev Y & Zhakypbayev A (2012) Morris Animal Foundation Framework Grant Fauna and Flora International Technical Report: Rapid Response to the Saiga Antelope Emergency in Western Kazakhstan. DOI:10.13140/RG.2.2.11946.64960
5. Orynbayev M, Sultankulova K, Sansyzbay A, Rystayeva R, Shorayeva K, Namet A, Fereidouni S, Ilgekbayeva G, Barakbayev K, Kopeyev S, & **Kock R** (2019) Biological characterization of *Pasteurella multocida* present in the Saiga population. *BMC microbiology*, 19(1), 37. https://doi.org/10.1186/s12866-019-1407-9
6. Fereidouni S, Freimanis GL, Orynbayev M, Ribeca P, Flannery J, King DP, Zuther S, Beer M, Höper D, Kydyrmanov A, Karamendin K, & **Kock R** (2019) Mass Die-Off of Saiga Antelopes, Kazakhstan, 2015. *Emerging Infectious Diseases*, 25(6), 1169–1176. https://doi.org/10.3201/eid2506.180990
7. **Kock RA**, Orynbayev M, Robinson S, Zuther S, Singh NJ, **Beauvais W**, Morgan ER, Kerimbayev A, Khomenko S, **Martineau HM**, Rystaeva R, Omarova Z, Wolfs S, Hawotte F, Radoux, J, & Milner-Gulland EJ (2018) Saigas on the brink: Multidisciplinary analysis of the factors influencing mass mortality events. *Science Advances*, 4(1), eaao2314. https://doi.org/10.1126/sciadv.aao2314

Other Quality Indicators

Professor Kock has secured research grants investigating the role of wildlife in the epidemiology of PPR totalling >GBP1,750,000 from quality peer-reviewed sources including Animal Health and Welfare (ANIHWA) ERA-NET (2013-2017), which funded some of the above underpinning research, Biotechnology and Biological Sciences Research Council Global Challenges Research Fund (2017-2019) and Global Research Translation Awards/Engineering and Physical Sciences Research Council (2019-2021). These latter 2 PPR grants were secured based on Kock's international expertise in wildlife and leadership of One Health approaches to field-based research. In 2015 a NERC emergency grant was awarded funding a joint programme involving RVC, the Kazakh Research Institute for Biological Safety Problems, Imperial College London/University of Oxford, Bristol University, Association for the Conservation of Biodiversity of Kazakhstan (ACBK) and Frankfurt Zoological Society).

Other quality indicators of Professor Kock's standing in the field include: He is a member of expert working groups including: UN Environment Programme (UNEP) Global Environment Outlook (2017) Assessment Pan–European Region, Lead Author; UNEP Convention on the Conservation of Migratory Species (CMS) (2019) Medium-Term International Work Programme for the saiga antelope (2021-2025); He holds fellowship/board membership for: Wildlife Disease Association (WDA) 2014-2019; Co-Chair IUCN Species Survival Commissions Wildlife Health Specialist Group and received the Al Franzmann Memorial Lecture to WDA award in 2016, which commends the top research in wildlife disease each year. Kock also received the WDA

Tom Thorne and Beth Williams Memorial Award in 2020, which is presented in acknowledgement of either an exemplary contribution or achievement combining wildlife disease research with wildlife management policy implementation or elucidating particularly significant problems in wildlife health. Reference 7 is in the top 5% for its field based on field weighted citation indices, and references 2 and 6 are in the top 10%.

4. Details of the impact (indicative maximum 750 words)

There are 3 elements of impact resulting from Kock's research to understand MMEs in the critically endangered saiga antelope: (i) the importance of monitoring the health of wildlife small ruminants in efforts to control and eradicate the viral disease PPR through measures including livestock vaccination; (ii) the need to change regulations to enable movement of biological samples when investigating disease outbreaks in endangered wildlife and (iii) protection of saiga through trade and hunting restrictions to allow populations to recover. Kock's work has led to far-reaching changes with potential for benefits to domestic small ruminants, particularly those that are a food source for some of the poorest people in the world. In addition, his work has impacted on wildlife conservation and helped to protect and restore the iconic species, saiga, and enabled more rapid response to disease outbreaks in endangered wildlife in the future which could impact, not only on the health of those wildlife but also public and animal health in general.

i. PPR control and the role of livestock

PPR is emerging globally as a serious pandemic, affecting a wide range of hoofed mammals, impoverishing livestock keepers and threatening biodiversity.

Kazakhstan: A vaccination programme for domestic ruminants had been in place in the border regions of Zhambyl and South Kazakhstan oblast, and partially in the border regions of Almaty and Kyzylorda oblast since 2006. Despite this vaccination strategy, outbreaks were recorded in 3 organized farms, mainly in young animals – these were investigated by Kock in collaboration with the Research Institute for Biological Safety Problems [2]. Changes to the PPR virus control programme around the borders of Kazakhstan were instituted from 2014 [a] as a result of this collaborative investigation. Further incursion of PPR virus into Kazakhstan in 2014-15 would have coincided with the Pasteurella outbreak (2015 MME), which, in ACBK's view would have made extinction of the Kazakh Betpak-dala saiga population probable [a]. The substantial numbers of livestock vaccinated, including youngstock, together with the serological monitoring conducted to inform the vaccination strategy has controlled PPR in the regions neighbouring the saiga grazing and no outbreaks of PPR have been reported since 2018. Vaccination continues and the Committee of Veterinary Control and Supervision of the Ministry of Agriculture of the Republic of Kazakhstan confirm that a strategy for the prevention and control of PPR has been developed and implemented [a]. The SOPs for monitoring the health status of saiga (below) are an important component of this PPR prevention strategy based on the Mongolian experience.

Mongolia: PPR was unknown in Mongolia until a livestock outbreak in 2016. In the subsequent saiga MME, RVC research identified PPR as the causative agent and demonstrated the role of wildlife (principally saiga and Ibex) as a critical indicator of failure of the vaccination programme (10,000,000 vaccinations of sheep and goats at a cost of USD1,636,440 [10-2016]) instigated to halt viral spread and as an unforeseen factor influencing the PPR epidemic [b]. Kock's work then informed a strategy to include participatory surveillance of wildlife and more extensive vaccination efforts, to better protect both livestock and wildlife. The RVC and the scientific advisory group advised the General Authority for Veterinary Services reviewing and improving the livestock vaccination strategy to take account of the wildlife factor, aimed at ensuring lifetime immunity of stock likely to be in contact with Saiga [b, c].

Global Policy changes incorporating wildlife surveillance in PPR control (FAO led)

RVC's research in Mongolia has led to a better understanding of the risk factors and likely outcomes which underpin recommendations relating to the livestock-wildlife interface in PPR management strategies. FAO is disseminating these principles via the PPR global research network, involving many national veterinary services and has incorporated them into the Global Eradication Programme [b]. Thus, national and international changes have been implemented as a result of this research.

Mongolian Animal Health Law: The PPR outbreak in Mongolia was the first time this virus had been shown to cause disease in wildlife. Kock and the FAO rapid response team made

recommendations for appropriate actions, which coincided with the Mongolian government's review of animal health legislation. In consequence, the new Law on Livestock and Animal Health incorporated wildlife health components and came into force on 1 June 2018, making it mandatory that 1) wildlife be considered as a critical factor in transboundary disease outbreaks, and 2) targeted surveillance of species be undertaken [c, d, e].
Mongolian National Strategy on PPR Control: The full Mongolian National PPR Strategy (in which wildlife surveillance features prominently [b]) has still to be finalised but, recognising its importance and urgency, a publically available PPR Prevention and Control Guideline incorporating new wildlife recommendations [f], (approved and operational from 4 January 2019 [b, c, d, f]), has been produced as a result of the scientific advisory group's recommendations.
FAO/OIE PPR Global Eradication Plan (GEP): Research from the RVC and the scientific advisory group has provided important input into the PPR GEP 2022-2027, due for publication in 2021 where considerations of wildlife feature prominently [b]. In order to be officially classed as PPR free, countries must now survey both livestock and wildlife. Kock's research around saiga and other wildlife in eastern Africa and Central Asia highlighted wildlife as a critical factor in PPR control, and the need to improve in-country capacity to deal with these issues. FAO/OIE consider this understanding of the role of wildlife in PPR epidemiology to be important enough to produce new Guidelines for the Control and Prevention of Peste des Petits Ruminants (PPR) in Wildlife Populations [g], ahead of the release of the new PPR GEP in 2021. Kock contributed to these new guidelines, which are now under implementation [b, g]. FAO are promoting the approach taken by Mongolia to consider the impact of wildlife in PPR control in a wider context, which could also be valuable for controlling other diseases within the One Health framework [b].

ii. Simplifying and speeding international movement of biological samples
Trade restrictions on products from endangered species necessitate bureaucratic paperwork to accompany research samples, which can affect sample integrity and delay diagnosis. Prompted by the saiga research experience of the Kazakh MME, Kock and colleagues from the International Union for Conservation of Nature (IUCN) wrote an editorial in *EcoHealth* to raise awareness of this problem, which detailed constraints and made recommendations. As a result, the Convention on International Trade in Endangered Species (CITES) set up a Working Group on Simplified Procedures for Permits and Certificates. Its recommendations, adopted in August 2019 [h], provide exemptions for emergency situations, enabling samples for all terrestrial and marine systems worldwide to be moved in days, rather than months [h].

iii. Influence on conservation classification and status under international treaties
CITES: In 2002, saiga were placed in CITES Appendix II (species not threatened with extinction, but may become so unless trade is closely controlled), to recognise the threat from increased saiga horn trade. In August 2019, the Parties to CITES considerably strengthened the restrictions by agreeing a zero quota for export and import of saiga products. This decision was influenced by RVC research showing the extent and causes of the Kazakh MME and Mongolian PPR outbreak, and potential for future similar disease outbreaks, exacerbating the threat of extinction [h]. RVC work demonstrated that the population in Mongolia reduced by >85% (25,000 to approximately 3000) in 2017, rather than the 40% figure promulgated by the Mongolian government [e]. Since the trade ban was implemented, saiga numbers in Mongolia have increased to approximately 5000 [e].
IUCN: In response to threats from increased horn trade, the IUCN categorised saiga as 'critically endangered' in their global extinction Red List (2002/2008) [i]. The 2018 update cites RVC research [7], identifying MME from disease as an additional significant risk factor [i].

Promotion of Kazakh saiga population recovery and protection
Following the collapse of the USSR and withdrawal of Russian support, saiga – an emblematic animal for Kazakhstan - has increased in importance as a food resource. Saiga reproductive capacity means that herds can recover from harvesting quite quickly, if managed appropriately. These factors have influenced the Kazakh responses to the MME research and co-operation with international and independent organisations.
Standard Operating Procedures and surveillance strategies impacting saiga conservation: Kock has worked closely with organisations including ACBK and FAO to develop a Kazakh strategy for saiga conservation which also serves as surveillance for PPR incursion

into Kazakhstan under FAO requirements for wildlife surveillance (see above). Health is now addressed by epidemiological monitoring, training on SOPs developed jointly between RVC, ACBK, FAO and Kazakh authorities, and establishment of a rapid response group [a]. SOPs and surveillance strategies are currently managed with the assistance of NGOs until this can be fully transitioned to the government and is able to operate without additional support. The Kazakhstan Government has indicated their support for these strategies [a]. The SOPs developed as a result of Kock's investigative research into saiga MME were sponsored by CMS and incorporated into CMS Medium Term International Work Programmes (MTIWP) for Saiga Antelope 2016-2020 and draft MTIWP 2021-2025, publically available in English and Russian [j].
Areas re-categorised: In November 2012, an area of 489,766ha including the calving zone of the Betpak-dala saiga population was categorised as a State Nature Reserve, through the Altyn Dala Project, to support migrating populations of saiga and other wildlife [a]. ACBK state *'The need for the Altyn Dala reserve and the ability to maintain subpopulations of saiga and limit their contact with domestic livestock was underlined by your research identifying the prevalence of highly infectious diseases circulating with in saiga'* [a]. In ACBK's view, establishment of the reserve in conjunction with the PPR vaccination strategies stimulated by Kock's research saved the Betpak-dala population of saiga from likely extinction resulting from the 2015 MME [a]. Saiga numbers in that population have since increased from 36,000 in 2016, to 111,500 in 2019 [a].

5. Sources to corroborate the impact (indicative maximum of 10 references)
All evidence has been uploaded with the submission, unless otherwise stated as held by RVC.
a. Letter and email from ACBK plus letters from Kazakh Ministries [in both English and Russian]. corroborating annual saiga numbers and the role of RVC research in SOPs, surveillance strategies, the Altyn Dala reserve and changes to the PPR virus control programme.
b. Letter from FAO corroborating role of RVC research in SOPs and surveillance strategies, identifying PPR as the causative agent in the Mongolian MME, the role of wildlife as a critical indicator of failure of PPR vaccination programme, and in changing PPR prevention and control strategies and policies, plus Fine et al (2020) Eradication of PPR Virus and the Wildlife-Livestock Interface. *Frontiers in Veterinary Science* 7, 50. https://doi.org/10.3389/fvets.2020.00050
c. Letter from General Authority for Veterinary Services, Mongolia corroborating review and improvement of the livestock vaccination strategy to take account of the wildlife factor and implementation of Mongolian Animal Health Law and National PPR Control Guidelines.
d. Letter from WCS corroborating impact in Mongolia and changes in saiga numbers.
e. Mongolian Animal Health Law [in Mongolian, with English translation included for convenience] showing it is mandatory that 1) wildlife be considered as a critical factor in transboundary disease outbreaks, and 2) targeted surveillance of species be undertaken.
f. Mongolian National PPR Control Guidelines [Mongolian] inc. RVC wildlife recommendations.
g. Email from FAO/OIE verifying approval of new FAO/OIE Guidelines for the Control and Prevention of PPR in Wildlife Populations, plus copy of the approved guidelines.
h. Letter from CITES corroborating role of RVC research in CITES classification of saiga and zero quota on import and export of saiga products, plus Editorial: Karesh WB and Kock RA and Machalaba CC (2016) CITES: In Sickness and in Health? *Ecohealth*, 13 (3) 441-442. https://doi.org/10.1007/s10393-016-1154-4 and CITES 18th meeting of the Conference of the Parties Geneva (Switzerland), 17–28 August 2019. Simplified procedures for permits and certificates https://cites.org/sites/default/files/eng/cop/18/Com_II/E-CoP18-Com-II-14.pdf
i. 2018 IUCN Red List for saiga citing RVC research http://www.iucnredlist.org/details/19832/0
j. Letter and communique from CMS corroborating RVC involvement in MTIWPs plus CMS MTIWP for saiga antelope (2016-2020) and draft MTIWP (2021-2025) [in English and Russian].
- https://www.cms.int/sites/default/files/document/unep-cms_saiga%20mos3_mr_annex%205_mtiwp2016-2020_rev_eng_0.pdf
- https://www.cms.int/sites/default/files/document/unep-cms_saiga%20mos3_mr_annex%205_mtiwp2016-2020_rev_rus_0.pdf
- https://www.cms.int/saiga/sites/default/files/document/draft_saiga-mtiwp_2021-2025_en.pdf
- https://www.cms.int/saiga/sites/default/files/document/draft_saiga-mtiwp_2021-2025_ru.pdf