

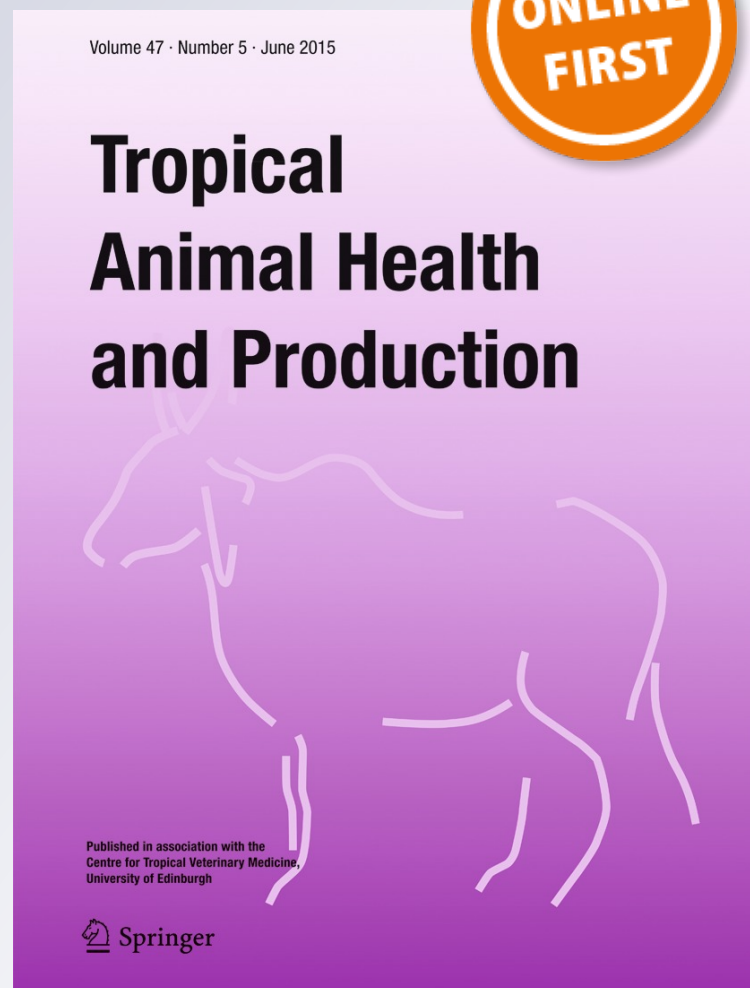
*Informal inter-island poultry movement  
in Indonesia: does it pose a risk to HPAI  
H5N1 transmission?*

**Joanne Millar, Muktasam Abdurrahman,  
Jenny-Ann Toribio, Annie Ambarawati,  
Ria Puspa Yusuf & Wayan Suadnya**

**Tropical Animal Health and  
Production**

ISSN 0049-4747

Trop Anim Health Prod  
DOI 10.1007/s11250-015-0857-9



**Your article is protected by copyright and all rights are held exclusively by Springer Science +Business Media Dordrecht. This e-offprint is for personal use only and shall not be self-archived in electronic repositories. If you wish to self-archive your article, please use the accepted manuscript version for posting on your own website. You may further deposit the accepted manuscript version in any repository, provided it is only made publicly available 12 months after official publication or later and provided acknowledgement is given to the original source of publication and a link is inserted to the published article on Springer's website. The link must be accompanied by the following text: "The final publication is available at [link.springer.com](http://link.springer.com)".**

# Informal inter-island poultry movement in Indonesia: does it pose a risk to HPAI H5N1 transmission?

Joanne Millar<sup>1</sup> · Muktasam Abdurrahman<sup>2</sup> ·  
Jenny-Ann Toribio<sup>3</sup> · Annie Ambarawati<sup>4</sup> ·  
Ria Puspa Yusuf<sup>4</sup> · Wayan Suadnya<sup>2</sup>

Received: 22 December 2014 / Accepted: 18 May 2015  
© Springer Science+Business Media Dordrecht 2015

**Abstract** Informal movement of domesticated poultry and wild birds is considered a major threat in terms of highly pathogenic avian influenza (HPAI) H5N1 transmission between birds and from birds to humans. However, the risk of transmission from informal illegal poultry movement has received little attention in Indonesia where human fatalities are the highest in the world. This research investigated the illegal movement of adult poultry between the islands of Java, Bali and Lombok to determine the potential risk of HPAI H5N1 transmission. The aim was to determine known origins and destinations of poultry, estimated quantity and types of birds, people involved and the drivers of illegal movement. Transportation and handling methods and views on how to minimise illegal movement were also investigated. In-depth interviews were carried out with 71 key informants in Bali and Lombok in 2009. East Java was the main origin of poultry entering Bali, followed by Central Java and Lombok. Interviewees estimated that over 10,000 village chickens, 500 ducks and 50 fighting cocks were brought into Bali per month from all origins. However, there were significant discrepancies with quarantine records indicating that the majority of

birds imported illegally are not detected. We conclude that although informal illegal movement of poultry in Indonesia poses a potentially high risk for potential HPAI H5N1 transmission if birds are infected, much can be done to increase surveillance, encourage reporting of sick birds, educate traders about the risks and provide effective quarantine within an appropriate cultural framework.

**Keywords** Livestock movements · Highly pathogenic avian influenza · Informal trade · Indonesia · Poultry · Illegal movement

## Introduction

Transportation of infected domesticated poultry and wild birds is considered a major threat in terms of the transmission of highly pathogenic avian influenza (HPAI) H5N1 between birds and from birds to humans (Van Borm et al. 2005; Kilpatrick et al. 2006; Van den Berg 2009). Most research on HPAI H5N1 transmission and outbreaks has been associated with commercial poultry production and legal movement between formal markets (Van Kerkhove et al. 2009; Sanchez-Vizcaino et al. 2010; Biswas et al. 2011; Desvaux et al. 2011; Fourniéa et al. 2013).

Less is known about the risks associated with informal movement of live poultry or wild birds, should they be infected with the HPAI H5N1 virus (Van den Berg 2009; Wang et al. 2010). Informal movement or trade can mean movement that takes place without having formal documentation but is still allowed by the law (e.g. village to village). Illegal movement, on the other hand, is informal trade that is against the law or regulation. Van den Berg (2009, p. 96) describes illegal trade as “The illegal importation of animals and their products

✉ Joanne Millar  
jmillar@csu.edu.au

<sup>1</sup> Charles Sturt University, PO Box 789, Albury, NSW, Australia 2640

<sup>2</sup> Research Center for Rural Development, Mataram University, Indonesia Mataram University, Jl. Pendidikan No. 37, Mataram 8312, Lombok, Indonesia

<sup>3</sup> Faculty of Veterinary Science, Camden Campus, The University of Sydney, J.L. Shute Building, 425 Werombi Road, Camden, NSW, Australia

<sup>4</sup> Agribusiness Study Program, Faculty of Agriculture, Udayana University, Jl. P.B. Sudirman, Denpasar, Bali 80232, Indonesia

includes all attempted third-country importations at places other than border inspection posts, and importations 'under cover' at inspection posts to evade normal import requirements".

In Southeast Asia, informal illegal movement of domesticated poultry, fighting cocks and wild birds is extensive (Van den Berg 2009). This illegal movement poses a high risk of HPAI H5N1 transmission due to the high poultry numbers being transported and housed together, and the lack of biosecurity measures (Rappole and Hubálek 2006; Van Kerkhove et al. 2009; Wang et al. 2010). While the drivers of illegal movement of poultry are mostly economic, they can also be social and cultural. Live chickens, ducks and turkeys are often exchanged between owners for breeding, fattening, showing or consumption (Ramdas 2009; Alders et al. 2014). In many countries, poultry are used for ceremonial or religious purposes with high-demand periods during festival and wedding events (Aklilu et al. 2007; Van Kerkhove et al. 2009; Wiratsudakul et al. 2014). For example, Van Kerkhove et al. (2009) found a remarkable increase in live poultry trading reported in Cambodia via market sellers and middlemen in the weeks prior to the Chinese and Khmer New Year festivals. Most of the human cases of HPAI H5N1 and approximately half of the domestic poultry outbreaks in Cambodia had occurred between these two annual holidays.

HPAI H5N1 has been prevalent in Indonesia since 2003, resulting in 195 cases of human infection of which 165 have been fatal mostly in Java but also on the islands of Sumatra, Sulawesi, Bali and Lombok (WHO 2014). Poultry outbreaks have occurred in all but one of the 34 provinces in Indonesia, and these have had significant social and economic impacts to poultry producers and the industry (Hartono 2004; Rushton et al. 2005; Basuno et al. 2010; Alders et al. 2014).

The entry and spread of HPAI H5N1 in Indonesia continues, most likely via both legal and illegal movement of infected poultry, despite control programmes focused on movement regulations, culling and vaccination (Thornton 2008; McLeod et al. 2009; Naysmith 2014). The regional governor decree no. 71 and decree from the Directorate General of Livestock Production no. 17/Kpts/PD 640/F/02.04 both state that adult birds are not allowed to be transported from infected to non-infected areas and that between provinces, only day-old chickens (DOC) are allowed to be moved (MOA 2004). The only province to have experienced very few, small outbreaks and to remain largely HPAI H5N1 free is Nusa Tenggara Timur or NTT (the far eastern islands of Flores, Sumba, Alor and West Timor). This province has strict adherence to the governor decree, strong collaboration and political will between government and the poultry industry in NTT, and education programmes. There is limited incentive for illegal movement of poultry into NTT as there are few social ties with neighbouring provinces and local production meets demand (Geong and Toribio 2012).

As in other countries, there has been considerable research on the risks of formal poultry movements in Indonesia via market chains and live-bird markets in terms of HPAI H5N1 transmission (Rushton et al. 2005; Thornton 2008; McLeod et al. 2009; Naysmith 2014). These studies have shown that biosecurity measures such as separating sick birds, disinfecting areas and wearing protective clothing are often inadequate at live-bird markets (Thornton 2008; Forster 2009; Naysmith 2014). However, the risk of HPAI H5N1 transmission via informal illegal movement in Indonesia has received less attention due to the inherent difficulties in data collection.

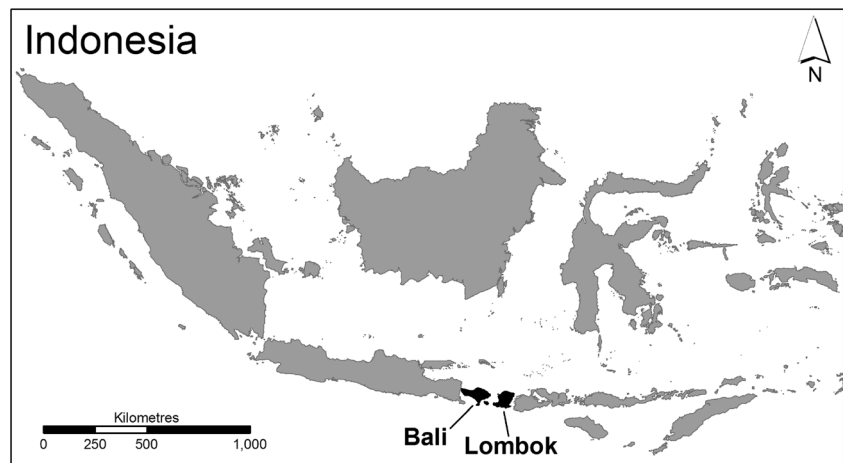
Informal illegal movement can occur at or outside official Indonesian ports where authorities may be absent or they do not detect poultry so they cannot observe the health status of live poultry. In addition, people may be reluctant to report sick birds or illegal movements for fear of penalties or restrictions (Barennes et al. 2007; Schiffer et al. 2008). Illegal movement of adult birds is often facilitated by bribes, adding another layer of complexity to investigations. Cognisant of these potential constraints, we embarked on a study to investigate the illegal movement of adult poultry between the islands of Java, Bali and Lombok to determine the potential risk of HPAI H5N1 transmission. The aim was to determine the known origin and destinations of poultry, the estimated quantity and types of birds, the people involved, the drivers of informal illegal movement, the nature of transportation and handling of poultry and views on how to manage illegal movements.

## Methods

The research was approved by the Murdoch University Human Research Ethics Committee, Perth, Western Australia. The study was carried out on the islands of Bali and Lombok in Indonesia during 2009 (Fig. 1).

In-depth interviews were conducted with 71 key informants, 38 interviewed in Bali and 33 in Lombok. The key informants were quarantine staff, provincial and district livestock staff, port officers, policemen, collectors and traders, and local leaders of villages with high HPAI H5N1 risk based on occurrence of outbreaks and close proximity to locations where inter-island adult bird movements are likely to occur. Snowball sampling was applied to identify key informants who could provide data and information on informal bird movements (Lewis-Beck et al. 2004). The snowball sampling method, a standard social research technique, starts with selection of informants known for their expertise. They are then asked to suggest others who can provide relevant information and so on, in the quest to obtain comprehensive information (Noy 2008).

**Fig. 1** Location of Bali and Lombok in Indonesia



In-depth interviews were selected as the most appropriate technique to get comprehensive information on illegal movement activities due to the opportunity to build relationships and ensure confidentiality (Marshall and Rossman 2006; Babbie 2011). Observations were also carried out at official and non-official ports and quarantine offices to verify responses or pick up any unexpected activities.

Table 1 summarises the distribution of key informants interviewed in Bali and Lombok according to their professional background.

The sites purposively selected for inclusion in this research were areas on the islands of Bali and Lombok where inter-island movement of adult birds is likely to take place (Fig. 2). Three areas were selected in Bali, namely *Gilimanuk* (western part of Bali, close to Banyuwangi, East Java), *Celukan Bawang* (northern part of Bali) and *Padangbai* (eastern part of Bali, connecting to Lombok). In Lombok, three areas were selected, namely *Labuan Lombok* and *Labuan Haji* (two

harbours at the eastern part of Lombok—connecting Lombok and Sumbawa) and *Pelabuhan Lembar* (western part of Lombok, connecting Lombok and Bali).

An interview guide was constructed to obtain information on the known origin and destination of poultry movements, the estimated number and adult poultry involved, transport and handling of birds during transportation, people involved, drivers of illegal movement and views on how to minimise illegal movement. Secondary data was also obtained from the quarantine office in Bali on numbers of birds caught, rejected and eradicated.

## Results

### Origins and destinations of informal illegal movement

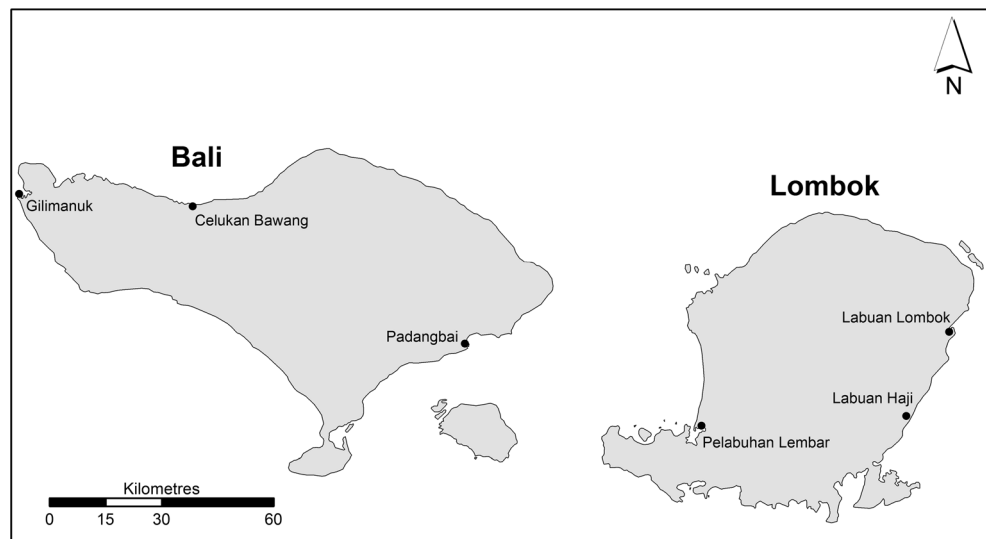
Six places of origin for illegal movement of birds into Bali were identified by key informants in the study (Table 2). East Java was nominated as the main origin including Madura (an island with several districts near Surabaya, the capital city of East Java province), Probolinggo, Jember and Banyuwangi (districts closest to Bali). The other two origins of adult birds mentioned were Lombok and Central Java (Yogyakarta). Destinations for each of the origins are shown in Table 2 and graphically in Fig. 3 to give a sense of distances and direction. All routes from Java go through the main port of Gilimanuk (Fig. 2).

Figure 3 shows the direction of poultry movements between origin and destinations according to key informants. Despite the claim by all government staff in Lombok that there was no illegal movement from Lombok to Bali and vice versa, Bali key informants identified Lombok as a place of origin and destination of illegal movement of birds. Two illegal movement cases from Lombok were observed during the study. One case observed was at the arrival gate of Jakarta airport, where a person brought a fighting cock from Lombok

**Table 1** Key informants interviewed in Bali and Lombok

Profession	Bali		Lombok	
	<i>n</i>	%	<i>n</i>	%
Provincial and district livestock staff	7	18.4	9	27.3
Quarantine officers	6	15.8	6	18.2
Police	2	5.3	7	21.2
Sea port office	1	2.6	2	6.1
Village leaders	3	7.9	9	27.3
Farmers (poultry producers)	8	21.1	0	0
Collectors	6	15.8	0	0
Vendors	5	13.2	0	0
Total	38	100	33	100

Note: poultry producers, collectors and vendors were not interviewed in Lombok as there were no villages or markets with AI outbreaks at the time

**Fig. 2** Location of key informants

to Jakarta on the plane but was not arrested. Another case was found where a ferry passenger brought a songbird from Lombok to Bali.

### Estimated types and numbers of birds

Bali key informants estimated that the total number of adult birds brought into Bali per month was 11,345 (378 per day) from all origins. Lombok key informants believed that illegal movement of birds into Bali was very minor, so they did not offer estimates. As a Lombok quarantine officer said “there is no live adult poultry transported to Bali from Lombok or from other provinces to Lombok since the provincial government bans the transportation of adult poultry”. However, some Lombok informants at the live-bird markets and villages stated that some fighting cocks were likely transported to Bali by traders in Mataram but they were unwilling to give estimates or name the traders.

The majority of birds brought over were kampung chickens (local village chickens) and ducks estimated at more than 10,000 chickens and around 500 ducks (Table 3). This is due to the high demand in Bali for kampung chickens and ducks for

ceremonial purposes, particularly during Hindu festivals. Ornamental birds are also brought into Bali because of the high demand for pet birds (Table 3). Illegal movement of muscovies and fighting or ornamental cocks is not as high according to key informants.

### Number and types of adult birds from Java caught by quarantine at Gilimanuk, the main entry port from Java

In contrast to the estimates above, data provided by the Bali Quarantine Office showed that from January 2008 to March 2009 (over 14 months), only 8500 birds (610 per month or 1.8 birds per day) were caught at the main entry port of Gilimanuk as shown in Table 4. According to the official data, fighting cocks are the most dominant type of bird caught at 192 per month, indicating that interviewees severely underestimated fighting cock numbers. The highest number of fighting cocks is caught during March due to the peak demand for fighting cocks in Bali at this time. The second highest number of birds caught is ornamental birds, mostly from Jombang (East Java) and Yogyakarta (Central Java).

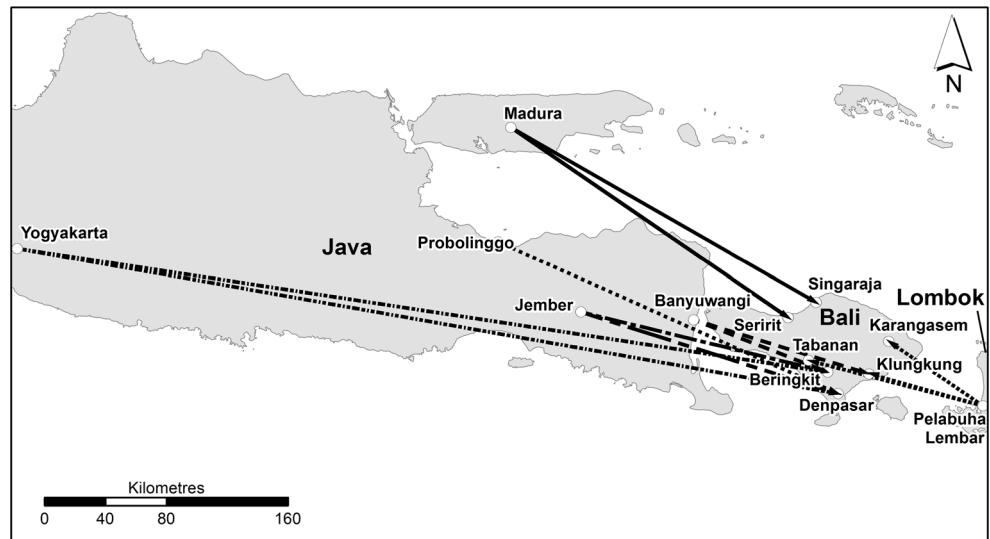
The numbers of ducks, kampung chickens and broilers reported as caught at Gilimanuk ports were less than those of fighting cocks and ornamental birds. The suspected reason for this is the higher value of fighting and ornamental birds which command a higher penalty price and the illegal nature of the fighting cock industry.

According to the key informants at the Bali Quarantine Office, people with caught birds are arrested then birds are either rejected or eradicated. The quarantine officers conduct a rapid test to check if the birds test positive for HPAI. If found to be positive, then the birds are detained at a certain place

**Table 2** Identified origins and destinations of adult poultry

Origin (Java, Lombok)	Destination (Bali)
Banyuwangi, East Java	Beringkit, Klungkung, Bali
Probolinggo, East Java	Denpasar, Bali
Madura, East Java	Seririt, Singaraja, Bali
Jember, East Java	Beringkit, Denpasar
Yogyakarta, Central Java	Beringkit, Denpasar
Lombok	Tabanan, Klungkung and Karangasem

**Fig. 3** Direction of adult poultry movements between Java, Bali and Lombok



near the port to be eradicated. Eradication is witnessed by police, village heads, community leaders and the quarantine staff and reported in local newspapers. If the birds caught do not test positive for HPAI, the birds are returned to the owners or traders but they are not allowed to enter Bali.

Table 5 reveals actions taken by the Bali Quarantine Office regarding caught birds during July 2008 to March 2009. About 2701 birds (including fighting cocks, ornamental birds, muscovies and ducks) or 48 % of birds smuggled were eradicated, while the rest were rejected.

The highest number of ducks caught and eradicated was 792 in August 2008, coming from Banyuwangi in East Java. Muscovies also attract illegal movement activity into Bali as the prices are quite good due to the high demand for ceremonial activities and for Balinese dishes. The seizure of broilers and spent layers by Quarantine also shows that birds most likely produced by commercial producers for normal consumption are illegally brought into Bali, a point not mentioned by

key informants who discussed principally kampung chickens and ducks which are more common.

Given that the reported number of caught birds is only 5 % of the estimated number of adult birds brought into Bali by the key informants, it can be concluded that the majority of birds are not detected by the Sea Port Authority and Quarantine Offices. Reasons given by the Bali quarantine staff interviewed were lack of personnel to run 24-h inspections at the port, difficulty in seeing at night and lack of time for proper inspection of all vehicles. One interviewee explained that when vehicles pass the checkpoint, it is common practice for the gate inspector to only “ask the drivers what they are bringing and check the driving license. If we perform strict inspections of buses and trucks, the drivers and passengers dislike the delays and it creates traffic jams”.

**Table 3** Estimated numbers and types of birds brought into Bali from all origins (N=38)

Types	Estimated average number per month	%
Kampung chicken	10,610	93.5
Duck	500	4.4
Variety of birds (songbirds, ornamental for pets)	120	1.1
Muscovies	60	0.5
Fighting cock	50	0.4
Ornamental cock	5	0.04
Total	11,345	100

**Table 4** Number and types of adult birds caught by quarantine at Gilimanuk (January 2008–March 2009)

Types	Total number	Average number per month	%
Fighting cock	2688	192	31.7
Ornamental birds	2209	158	26.0
Duck	872	62	10.3
Broiler	859	61	10.1
Kampung chicken	782	56	9.2
Muscovies	760	54	8.9
Spent layer	300	21	3.5
Ornamental cock	14	1	0.2
Geese	3	0.2	0.04
Total	8487	610	100

Source: Bali Quarantine Office, 2009

**Table 5** Action taken by the Bali Quarantine Office for caught birds (July 2008–March 2009)

Action taken by Quarantine Office	2008							2009			Total
	Jun	Jul	Aug	Sept.	Oct	Nov	Dec	Jan	Feb	Mar	
Arrested	363	1812	1216	1070	18	27	216	41	262	554	5579
Rejected	2	1406	411	869	18	1	0	3	0	168	2878
Eradicated	359	406	805	201	0	26	216	38	262	386	2701

Source: Bali Quarantine Office, 2009

### People involved in illegal movement of adult birds

Bird collectors<sup>1</sup> were the most commonly mentioned people involved in informal illegal movement, followed by vendors and ordinary household members (Table 6). Others mentioned were bird fanciers, fishermen and truck drivers. According to key informants, collectors and vendors<sup>2</sup> bring larger numbers of birds into Bali while bird fanciers and truck drivers bring only a few birds as they do it for a hobby only.

### Drivers of illegal movement

The main driver of illegal movement into Bali according to most Bali key informants was the high demand for particular types of birds (e.g. kampong chicken with certain colours and fighting cocks) (Table 7). Due to the high demand, the illegal movement leads to making a good profit, as mentioned by 24 % of the key informants. The other drivers stated by informants were “doing illegal movement to earn a living,” “desire to have different type of birds, such as ornamental birds” and “to avoid tax”.

### Transportation and handling of birds during informal movement

According to almost half of the Bali key informants, motorbikes are the main transportation for informal movements whether legal or illegal (Table 8). However, some informants noted that boats are used first to transport adult birds to the targeted shores or beaches or villages nearby Gilimanuk and Celukan Bawang ports. There are persons

<sup>1</sup> Collectors refer to the persons who collect chickens and ducks from all sectors of the poultry industry. The collector will either pick up chickens from farms on the way to the live-bird market or collect birds at a central point of collection.

<sup>2</sup> There are two types of vendors: a permanent with a stall at the market and a mobile one. The mobile vendors usually move from one market to another in order to buy and sell birds.

**Table 6** People involved in bird illegal movement into Bali ( $N=38$ )

People involved	Number of mentions	%
Collectors	20	52.6
Vendors	6	15.8
Household member (non-commercial)	6	15.8
Bird fanciers	1	2.6
Fishermen	1	2.6
Truck drivers	1	2.6
No idea	3	7.9

Note: Lombok respondents did not answer this question since they maintained that illegal movement did not occur from Lombok to Bali

**Table 7** Drivers of illegal movement of birds into Bali ( $N=38$ )

Drivers of illegal movement	Number of mentions	%
High demand	18	47.4
Good profit	9	23.7
Earning a living	6	15.8
Getting different types of bird	2	5.3
Avoiding retribution/tax	1	2.6
No idea	2	5.3

Note: Lombok respondents did not answer this question since they maintained that illegal movement did not occur from Lombok to Bali

**Table 8** Transportation of adult birds ( $N=38$ )

Transportation type	Number of mentions	%
Motorbike	18	47.4
Bus	8	21.1
Truck	7	18.4
Open van	3	7.9
Boat	2	5.3

Note: Lombok respondents did not answer this question since they maintained that illegal movement did not occur from Lombok to Bali



**Table 9** Handling of adult birds ( $N=38$ )

Bird handling	Number of mentions	%
Bamboo basket	17	44.7
Roped and hung in motorbike	14	36.8
Small box	3	7.9
Sack	2	5.3
No idea	2	5.3

Note: Lombok respondents did not answer this question since they maintained that illegal movement did not occur from Lombok to Bali

then waiting to relay birds by motorbike. The second most used modes of transportation mentioned were bus and truck. According to quarantine staff interviewed, some people hide the birds under the bus seats or in the bus toilet or put the birds in boxes covered with other things to camouflage the birds.

When asked about the main ways of handling adult birds, about half the Bali informants said that bamboo baskets were the most common while others mentioned birds being roped onto the motorcycle. Another handling method is to put the birds into small boxes or sacks as shown in Table 9. However, these are common forms of handling poultry in both formal and informal movements.

### Perceptions on how to manage illegal movement activities

Most Bali informants said that law enforcement is very important for managing illegal movement of poultry. However, since illegal movement makes money for people and since there is no punishment or hard sanctions against smugglers, they feel powerless to strictly enforce the law. A few key informants felt that more information about the danger of HPAI H5N1 was needed as well as better coordination amongst institutions, such as the Quarantine Office, Water Police or Sea Port Officer (Table 10).

**Table 10** Perceptions on how to manage illegal movement ( $N=38$ )

Perceptions on how to manage illegal movement	Number of mentions	%
Law enforcement	31	81.6
More socialisation of HPAI H5N1	3	7.9
Better coordination amongst involved institutions	1	2.6
No idea	3	7.9

Note: Lombok respondents did not answer this question since they maintained that illegal movement did not occur from Lombok to Bali

### Discussion and conclusions

The informal illegal movement of poultry from Java to Bali was readily identified by 92 % of Bali informants despite the 2004 ban on live-bird movements other than day-old chickens (DOC). This finding indicates that illegal movement of birds into Bali is driven by profit incentives from bird sales and the high demand for particular types of birds in Bali. The price difference between bird source and destination is an important contributor. For example, in East Java, the price of a small kampung chicken ranges from IDR 8000–10,000 while in Bali it rises to IDR 10,000–15,000 for a collector and IDR 18,000–25,000 for a vendor or customer, depending on the bird colour and time of year (normal or religious festival). Forster (2009) describes even higher price differentials for chickens between other provinces and for ducks. Van Kerkhove et al. (2009) and Obi et al. (2009) also reported price differentials as key drivers of illegal movement of poultry into Cambodia and Nigeria.

Our findings also revealed that the majority of birds imported illegally are not detected by the Sea Port Authority and Quarantine offices. Reasons for the lack of surveillance appear to be lack of personnel, time and willingness to comprehensively find and survey all poultry so a sample approach is used. There appears to be reluctance by officials to disrupt the traffic or penalise traders. From a Western perspective, this may seem ineffective, but in many developing countries, the political and social imperatives are to maintain harmony in society (Barennes et al. 2007; Forster 2009). For government officers on relatively low incomes, the temptation of taking bribes and collusion with traders is omnipresent. Such behaviours might also explain why there were discrepancies in the types of birds reported to be brought across and those caught.

Chickens and ducks are very important for Balinese ceremonies, so the demand will continue as part of traditional culture (Forster 2009). For the most popular birds such as *itik jambul* (Jambul duck) or “white duck”, local Balinese farmers could be encouraged to rear more of these kinds of birds with supporting regulations and facilities. However, commercial operations would have to be able to adopt good bio-security practices to avoid contamination and outbreaks (Guene Bleich et al. 2009). Even so, if Javanese farmers can continue to produce poultry at a lower cost, then it will be difficult for Balinese farmers to compete and the illegal movement will persist. Therefore, reducing the risk of HPAI H5N1 transmission relies primarily on better surveillance, testing and reporting of sick birds by farmers, communities, traders, quarantine staff and vendors (Schiffer et al. 2008; Azhar et al. 2010; Wiratsudakul et al. 2014).

Most key informants recognised the need for more effective regulation to monitor bird movement into and out of the province, and detect sick birds. Increased surveillance activities would be required at every port in Bali and Lombok in

order to monitor illegal movement of birds from East Java to Bali and from Lombok to Bali. According to Sims (2012), surveillance programmes in most countries where HPAI H5N1 infection is endemic are heavily dependent on donor funding, and there are no guarantees that the funding will be provided for this purpose in the future. Therefore, surveillance needs to go beyond virus collection to address the sociology of illegal movements and to work with, not against, poultry traders (Naysmith 2014). For example, the frequent occurrence of poultry deaths in Indonesia means that it is considered normal and it is difficult for traders or farmers to determine if sickness or mortality is due to HPAI H5N1 or something else (Guerne Bleich et al. 2009; Alders et al. 2014). Fear of authority, possible penalties and lack of compensation can also influence people's willingness to report suspected HPAI cases (Barennes et al. 2007; Schiffer et al. 2008).

Regulatory measures such as rules, surveillance and penalties have been more effective when developed in consultation with traders and farmers (Barennes et al. 2007; Azhar et al. 2010). Such a system would rely on building trusting relationships between health officials and traders to allow confidence in reporting. Further research is needed into the capacity and willingness of stakeholders to adopt such an approach.

We conclude that illegal movement of poultry in Indonesia poses a high risk for potential HPAI transmission due to the high numbers and variety of birds being smuggled, the lack of surveillance at ports and the lack of law enforcement. However, much can be done to increase surveillance, encourage reporting of sick birds, educate traders about the risks and provide effective quarantine within an appropriate cultural framework.

**Acknowledgments** The authors would like to express gratitude to the governments of Bali and West Nusa Tenggara provinces and the community leaders and communities involved in the study for their collaboration, participation, and sharing of information on poultry movements. The authors also acknowledge the Australian Centre for International Agricultural Research (ACIAR) for funding this research as part of the Live-stock Movement and Managing Disease in Eastern Indonesia and Eastern Australia Project managed by the University of Sydney.

**Ethical approval** All procedures performed in studies involving human participants were in accordance with the ethical standards of the University of Sydney human ethics research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards.

**Conflict of interest** The authors declare that they have no competing interests.

## References

- Aklilu, H. A., Almekinders, C. J. M., Udo, H. M. J. and Van der Zijpp, A. J., 2007. Village poultry consumption and marketing in relation to gender, religious festivals and market access. *Tropical Animal Health and Production* 39, 165–177
- Alders, R., Awuni, J.A., Bagnol, B., Farrell, P. and de Haan, N., 2014. Impact of Avian Influenza on Village Poultry Production Globally. *Ecohealth*, 11, 63–72
- Azhar, M., Ade, A., Lubis, S., Sawitri Siregar, E., Alders, R.G., Brum, E., McGrane, J., Morgan, I. and Roeder, P., 2010. Participatory Disease Surveillance and Response in Indonesia: Strengthening Veterinary Services and Empowering Communities to Prevent and Control Highly Pathogenic Avian Influenza. *Avian Diseases*, 54, 749–753
- Babbie, E., 2011. *The Basics of Social Research*, (Wadsworth).
- Barennes, H.M., Martinez-Aussel, B., Vongphrachanh, P. and Strobel, M., 2007. Avian influenza risk perceptions, Laos. *Emerging Infectious Diseases*, 13 (7), 1126–1128
- Basuno, E., Yusdja, Y. and Ilham, N., 2010. Socio-economic Impacts of Avian Influenza Outbreaks on Small-scale Producers in Indonesia. *Transboundary and Emerging Diseases*, 57, 7–10
- Biswas, P. K., Rahman, M. H., Das, A., Ahmed, S. S. U., Giasuddin, M. and Christensen J. P., 2011. Risk for Highly Pathogenic Avian Influenza H5N1 Virus Infection in Chickens in Small-Scale Commercial Farms, in a High-Risk Area, Bangladesh. *Transboundary and Emerging Diseases*, 58 (6), 519–525
- Desvaux, S., Grosbois, V., Pham, T. T. H., Fenwick, S., Tollis, S., Pham, N. H., Tran, A. and Roger, F., 2011. Risk Factors of Highly Pathogenic Avian Influenza H5N1 Occurrence at the Village and Farm Levels in the Red River Delta Region in Vietnam. *Transboundary and Emerging Diseases* 58 (6), 492–502
- Forster, P., 2009. *The Political Economy of Avian Influenza in Indonesia*. STEPS working paper 17, STEPS Centre, Brighton, UK.
- Foumiéa, G., Guitiana, J., Desvaux, S., Cuong, V.C., Dung, D. H., Pfeiffer, D.U., Mangtanie, P. and Ghanif, A.C., 2013. Interventions for avian influenza A (H5N1) risk management in live bird market networks. *PNAS*, [www.pnas.org/cgi/doi/10.1073/pnas.1220815110](http://www.pnas.org/cgi/doi/10.1073/pnas.1220815110)
- Geong, M. and Toribio, J.A., 2012. Establishing preborder biosecurity-avian influenza control and poultry trade in East Nusa Tenggara province, eastern Indonesia. In *Animal Biosecurity in the Mekong: future directions for research and development*. ACIAR Proceedings. No. 137, (ACIAR, Canberra, Australia), 22–24
- Guerne Bleich, E., Pagani, P. and Honhold, N., 2009. Progress towards practical options for improving biosecurity of small-scale poultry producers. *World's Poultry Science Journal*, 65, 211–215
- Hartono, D., 2004. Economic impact of AI on price and supply of poultry product. Paper presented at National Workshop on Post Avian Influenza recovery (October 4–5 2004). PINSAR Unggas Nasional (Indonesian Poultry Information Centre). Direktorat Jenderal Bina Produksi Peternakan dan Food and Agriculture Organisation.
- Kilpatrick, A. M., Chmura, A. A., Gibbons, D. W., Fleischer, R.C. Peter P., Marra, P.P. and Daszak, P., 2006. Predicting the global spread of H5N1 avian influenza. *PLUS*, 103: 19368–19373.
- Lewis-Beck, M.S, Bryman, A. and Futing Liao, T.F., 2004. *The SAGE Encyclopedia of Social Science Research Methods*, (Sage Publishing, London).
- Marshall, C. and Rossman, G. B., 2006. *Data collection methods*, (Thousand Oaks, Sage Publications)
- McLeod, A., Kobayashi, M., Gilman, J., Siagian, A. and Young, M., 2009. The use of poultry value chain mapping in developing HPAI control programmes. *World's Poultry Science Journal*, 65, 217–224
- Ministry of Agriculture/MOA Decree, 2004: No: 17/Kpts/ PD.640/F/02.04, Manual on Prevention, Control, and Eradication of Spreading Animal Disease on Poultry or AI. Jakarta, Indonesia.
- Naysmith, S. 2014. Observations of a live bird market in Indonesia following an outbreak of avian influenza A (H5N1). *Ecohealth*, 11, 50–52

- Noy, C. 2008. Sampling knowledge: The hermeneutics of snowball sampling in qualitative research. *International Journal of Social Research Methodology*, 11 (4), 327–344.
- Obi, T. U., Garba, A.O. and Maina, A., 2009. Pro-Poor HPAI Risk Reduction Strategies in Nigeria—Background Paper, Africa/Indonesia Team Working Paper No. 5.
- Ramdas, S. R., 2009. Reclaiming endangered livelihoods: untold stories of indigenous women and backyard poultry, *World's Poultry Science Journal*, 65, 241–250
- Rappole J.H. and Hubálek Z., 2006. Birds and influenza H5N1 virus movement to and within North America. *Emerging Infectious Disease*, 12 (10), 1486–1492
- Rushton, J., Viscarra, R.E., Guerne Bleich, E. and Mcleod, A., 2005. Impact of avian influenza outbreaks in the poultry sectors of five South East Asian countries (Cambodia, Indonesia, Lao PDR, Thailand, Viet Nam) outbreak costs, responses and potential long term control, *World's Poultry Science Journal*, 61 (3), 491–514
- Sanchez-Vizcaino, F., Andres Perez, F., Manuel Lainez, M., and Sanchez-Vizcaino, J.M., 2010. A Quantitative Assessment of the Risk for Highly Pathogenic Avian Influenza Introduction into Spain via Legal Trade of Live Poultry. *Risk Analysis*, 30 (5), DOI: [10.1111/j.1539-6924.2009.01351.x](https://doi.org/10.1111/j.1539-6924.2009.01351.x)
- Schiffer, E., Narrod, C. and von Grebmer, K., 2008. The Role of Information Networks in Communicating and Responding to HPAI outbreaks, HPAI Research Brief No. 5 –Controlling Avian Flu and Protecting People's Livelihoods in Africa and Indonesia.
- Sims, L. D., 2012. Progress in Control of H5N1 Highly Pathogenic Avian Influenza and the Future for Eradication. *Avian Diseases*, 56, 829–835
- Thornton, R., 2008. Live Bird Market Studies in Bali. FAO Report.
- Van Borm, S., Thomas, I., Hanquet, G., Lambrecht, B., Boschmans, M., Dupont, G., Decaestecker, M., Snacken, R. and Van den Berg, T., 2005. Highly Pathogenic H5N1 Influenza Virus in Smuggled Thai Eagles, Belgium, *Emerging Infectious Diseases*, 11 (5) 702–705
- Van den Berg, T., 2009. The role of the legal and illegal trade of live birds and avian products in the spread of avian influenza, *Scientific and Technical Review of the Office International des Epizooties (Paris)*, 28 (1), 93–111
- Van Kerkhove, M.D., Vonga, S., Guitiand, J., Holle, D., Mangtanib, P., Sane, S. and Ghanic, A.C., 2009. Poultry movement networks in Cambodia: Implications for surveillance and control of highly pathogenic avian influenza (HPAI/H5N1), *Vaccine*, 27, 6345–6352
- Wang, L.Y., Hsuen, H. Y. and WanShan, L., 2010, Qualitative risk assessment of exotic highly pathogenic avian influenza entrance into Taiwan, *Taiwan Veterinary Journal*, 36 (2), 132–140
- Wiratsudakul, A., Paul, C.M., Dominique, J.D., Tiensin, T., Triampo, W., and Chalvet-Monfray, K., 2014. Modelling the dynamics of backyard chicken flows in traditional trade networks in Thailand: implications for surveillance and control of avian influenza, *Tropical Animal Health Production*, 46, 845–853
- World Health Organization. Cumulative number of confirmed human cases of avian influenza A/(H5N1) reported to WHO, 2014. Geneva: World Health Organization, [http://www.who.int/influenza/human\\_animal\\_interface/H5N1\\_cumulative\\_table\\_archives/en/](http://www.who.int/influenza/human_animal_interface/H5N1_cumulative_table_archives/en/)