Improving early detection of exotic or emergent oyster diseases in France: Identifying factors associated with shellfish farmer reporting behaviour of oyster mortality

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ABSTRACT

Farmers' vigilance is essential for the detection of epidemics, including potential emerging diseases, in marine shellfish. A field study was conducted to investigate oyster farmers' reporting practices and behaviour, and to identify factors influencing the reporting process of oyster mortality, with the ultimate aim of improving early detection of unexplained oyster mortality outbreaks.

A retrospective case-control study of oyster farmers from Charente-Maritime (France) was designed, based on interviews with 27 non-reporting and 89 reporting farmers, further split into 40 formerly-reporting and 49 currently-reporting farmers. Information about farmer and farm characteristics, farming practices, farm health history and related financial compensation on the farm, knowledge of the mortality reporting system and reporting behaviour was collected. Sampling design was considered in the calculations and farmers' reporting behaviour was modelled using an ordinal logistic regression (continuation-ratio model).

Notification procedures were fairly well known among farmers and the reporting system was well accepted overall. Nevertheless, a lack of awareness of the aims of the reporting system was revealed, which contributed to late reporting. Factors identified as driving a farmer's decision to report oyster mortality concerned their lack of awareness of mortality reporting (production type, farm size, location of the production cycle, accessibility of the leasing grounds) and willingness to report (possibility and extent of financial compensation, a feeling of not being involved, whether it was first year of reporting). Overall classification performance of the model built in this study was 64%. In particular, financial compensation for oyster production losses appeared to be a clear incentive for reporting, but was countered by a habituation effect combined with a lack of awareness of the aims of the reporting system: oyster farmers looking for benefits for themselves in reporting, rather than early detection of a disease outbreak.

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Both economic compensation and the farmers' non-economic values and perceptions should be considered to improve oyster farmers' reporting compliance and sustainability of the reporting system. Education and participatory approaches could help to change these attitudes and thus improve oyster farmers' compliance with reporting duties, resulting in improved early detection of epidemics and emerging or exotic oyster diseases.

1. Introduction

In France, the current surveillance system for marine mollusc health is mainly based on the observation of any increased shellfish mortality by shellfish farmers and its immediate mandatory notification to the local competent authority (European Union, 2006; French Ministry of Agriculture, 2008). But, although immediate notification of any observed mortality event is mandatory, the current definition of an increased shellfish mortality does not include objective criteria and mortality estimation is not straightforward: "*'increased mortality' means unexplained mortalities significantly above the level of what is considered to be normal for the [...] mollusc farming area in question under the prevailing conditions. What is considered to be increased mortality would be decided in cooperation between the farmer and the competent authority*" (European Union, 2006). Shellfish farmers have to complete a standardized notification sheet (French Ministry of Agriculture, 2010a). This mandatory document is a pre-tabulated paper form, which is filled in (usually by hand-writing) by the farmer. This form has to be immediately transmitted to the local competent authority. The national mollusc disease surveillance network (Repamo) then becomes involved, for anamnesis and laboratory diagnosis based on biological samples (Dufour and Hendrickx, 2009).

This system notably aims to early detect the appearance of any exotic or emerging pathogen in the territorial waters. Indeed, as diseased shellfish seldom show symptoms, any unexplained mortality is a potential indicator for pathogen introduction or emergence. This was well illustrated in 2008, when mortality notification data represented one of the rare data sources that both acted as an alert and described the extent of the mass mortality outbreaks which occurred in the spat of Pacific oyster, *Crassostrea gigas* (Miossec et al., 2009), associated with the detection of a newly described genotype (µVar) of the Ostreid herpesvirus (OsHV-1) (European Food Safety Agency, 2010; Segarra et al., 2010). Unfortunately, this infection has become endemic (Lupo et al., 2011b), showing that control of the spread of this emerging pathogen has failed.

Early detection of pathogen introduction or emergence in shellfish is crucial, as openness and connectivity of marine systems enable rapid disease spread (McCallum et al., 2004) and successful control of disease is very unlikely once established in shellfish populations (Lupo et al., 2012a). The use of drugs is not possible; therapeutic levels cannot be obtained economically or without unacceptable environmental impacts. Vaccination cannot be used because shellfish lack a true adaptive immune system, relying totally on their innate immune system to overcome diseases (Renault, 2009). However, there exists a window of opportunity to limit spread, which would need to be done mainly by restricting shellfish movements (European Union, 2006), and possibly by eliminating a pathogen early in an epidemic.

Like in any animal health surveillance system relying on the reporting of suspicious events, shellfish farmers are the best placed to inquire into and notify authorities of any suspicion of disease in the field (Dufour and Hendrickx, 2009). Their active involvement in this surveillance system is fundamental to make it effective, i.e. sensitive and timely to provide early alerts. However, a recent study has shown that participation of French oyster farmers in the mortality notification system was not sustained over the 2007–2010 time period (Lupo et al., 2012b). Since 2010, financial incentives have been implemented, with mortality notification becoming mandatory to qualify for financial compensation (French Ministry of Agriculture, 2010b). It is necessary to identify the incentives and barriers to the farmers' participation in the surveillance system in order to design an improved means of reporting (World Bank, 2010) and to help sustain farmers' motivation to report.

A few studies have investigated the reasons for farmer under-reporting diseases in livestock (Limon et al., 2013), cattle (Palmer, 2009; Bronner et al., 2013a, 2013b), sheep (Hopp et al., 2007), swine (Elbers et al., 2010a) and poultry (Elbers et al., 2010b) but, to our knowledge, this has never been investigated in shellfish farming. Thus, a study was conducted to investigate farmers' reporting practices and behaviour, and to identify factors influencing the reporting process of oyster mortality, with the ultimate aim of improving early detection of unexplained oyster mortality outbreaks.

2. Material and methods

2.1. Study design and population

The study was designed as a retrospective case-control study of oyster farmers from Charente-Maritime (France), using the oyster farmer as the epidemiological unit. Charente-Maritime is the main production region of Pacific oysters, *Crassostrea gigas*, in France, home to one third of all French oyster farms (Agreste, 2005). In particular, this is the main area of spat collection, supplying all the other regions with spat (Buestel et al., 2009). The study was conducted from March to December 2012.

Control farmers were randomly selected (by lottery using computer generated pseudo-random numbers) from the list of the oyster farmers who had notified authorities of at least one mortality event on their oyster production