

Article

Using AquaticHealth.net to Detect Emerging Trends in Aquatic Animal Health

Aidan Lyon ^{1,*}, Allan Mooney ² and Geoff Grossel ²

¹ Philosophy Department, University of Maryland, College Park, MD 20742, USA

² Department of Agriculture, Fisheries and Forestry, London Circuit, Canberra, Australian Capital Territory 2601, Australia; E-Mails: Allan.Mooney@daff.gov.au (A.M.); Geoff.Grossel@daff.gov.au (G.G.)

* Author to whom correspondence should be addressed; E-Mail: alyon@umd.edu; Tel.: +1-202-957-9744; Fax: +1-301-405-5690.

Received: 22 February 2013; in revised form: 27 April 2013 / Accepted: 28 April 2013 /

Published: 17 May 2013

Abstract: AquaticHealth.net is an open-source aquatic biosecurity intelligence application. By combining automated data collection and human analysis, AquaticHealth.net provides fast and accurate disease outbreak detection and forecasts, accompanied with nuanced explanations. The system has been online and open to the public since 1 January 2010, it has over 200 registered expert users around the world, and it typically publishes about seven daily reports and two weekly disease alerts. We document the major trends in aquatic animal health that the system has detected over these two years, and conclude with some forecasts for the future.

Keywords: aquaculture; intelligence; disease; biosecurity; aquatic animal health; digital disease detection; social epistemology

1. Introduction

In this paper, we document the output of an interdisciplinary project called AquaticHealth.net. This website was created because there was a need—in fact, an almost desperate need—to track and forecast outbreaks of aquatic animal diseases [1]. Knowing about an outbreak during its early stages is crucial to being able to act rapidly to contain it.

Every day, there is a wealth of information being put on the web that can help us work out where diseases are and where they are going. AquaticHealth.net gathers information and organizes it so that farmers, scientists, officials, and environmentalists can easily make sense of what is going on in the world of aquatic animal health at any given time.

Similar websites exist on the web, but none are devoted to aquatic animal health. In addition to deciding to fill this void, we decided to re-think how to best build such a system—sometimes called a digital disease detection system [2]. One important decision we made was a philosophical one. While computers are great at collecting and manipulating information on the web, they are not great at understanding that information. One day, there may be strong artificial intelligence, but today, humans are the only things that can truly understand information (see, e.g., [3] for discussion of the emergence of strong artificial intelligence and [4] for further discussion of the difference between human and automated understandings of semantic content). For this reason, we decided that human judgment should be an integral component to AquaticHealth.net. Therefore, in addition to aggregating masses of information, the system also aggregates human judgements about that information. The result is an important division of labor between computers and humans: get computers to find and organize information, and get humans to understand and make judgments about that information.

In the next section, Section 2, we describe briefly the basic mechanics behind AquaticHealth.net. However, our primary purpose of this paper is to document some of the major issues that AquaticHealth.net has identified since its inception (1 January 2010), and so we do not describe the methodology in detail. We direct the reader interested in such details to [1] and [5]. In Section 3, we describe 8 trends and events that have occurred in the last 2 years, their impact on aquatic animal health, and how AquaticHealth.net helped bring them to the attention of the Australian Department of Agriculture, Fisheries and Forestry.

Finally, in Section 4, we outline some tentative forecasts for what the future may hold. These are based on evidence and trends identified by the users of AquaticHealth.net. However, it is important to stress that these are not predictions with 100% certainty, far from it. Indeed, in the realm of disease outbreak forecasting, it is very difficult—perhaps sometimes impossible—to even assign probabilities to forecasts in any meaningful way, let alone make certain predictions. Nevertheless, as we will show, it is not as though nothing can be done in terms of forecasting.

2. AquaticHealth.net's Methodology

Every hour, AquaticHealth.net scans for thousands of news-media websites, blogs, forums, and Twitter for new information relevant to aquatic animal health. It does this using a comprehensive list of search terms, generated by the site's registered users. These search terms are classified in a variety of ways (e.g., by relevant host organism), and these classifications are used to help classify the search results. After some automatic pre-processing of the search results to remove most of the redundant and irrelevant information, the search results are pushed to the website into the Daily Scan as a list of reports, where they can then be viewed by the site's users.

The users of the site have a variety of backgrounds and motivations. They are comprised of government officials who are responsible for the aquatic health of their respective countries in various ways, research scientists working in aquatic animal science, individuals who are concerned with environmental issues and use the site to track harmful algal blooms (HABS), people who work in the

aquaculture industry in variety of ways (from fisheries production to equipment sales), and there are many individuals who have chosen not to give information about themselves. Anyone can join the site online, but many of the users have been recruited through scientific and industry conferences, social networks, and professional contacts. Users are not evaluated for their expertise, except that administrators check that they are human. So far, there have been no serious cases of abuse of the website or its information.

Although the Daily Scan list mostly contains information that is relevant to aquatic animal health, this information is often not about disease outbreaks, not even indirectly. Every day, some subset of the site's 200+ users look at the Daily Scan and push reports that they deem to be relevant or important in some way to another list called the Published Reports list. There are typically about seven such reports each day, and they are almost always relevant to aquatic animal disease outbreaks, if not directly about them. These reports are then further classified by the users, and the reports deemed to be most urgent are emailed out to all of the site's users, so that everyone sees the most important information.

Some of these reports will contain false or misleading information, or they may generate questions that the site's users wish to know the answers to. When this happens, a comment thread on the report opens up, and users can have a discussion about the report. This has been especially useful in correcting inaccuracies in the original reports, and all such comments are emailed out to everyone (who can opt out of the discussion threads, if they wish).

The result of this process is still often a large volume of information about an eclectic mix of events across the broad spectrum of aquatic animal health: from barramundi in Australia, to oysters in Ireland, to shrimp in Saudi Arabia. Even though the information has been automatically processed and analyzed by the site's users, it can still be difficult to put it all in context and develop a "big picture" understanding of what is happening. For this reason, the site contains a community-driven wiki-style blog called the Emerging Issues blog. All registered users can create blog posts or edit the posts of others. The idea is that each blog post summarizes the most relevant information about an event and embeds it in a larger narrative, so that the event can be understood in the larger context of surrounding events and ongoing issues.

3. Emerging Issues

In this section, we document some of the more significant issues that AquaticHealth.net (now abbreviated as AH) has found since 1 January 2010. Each of the following subsections has three components: (1) The issue: A basic outline of what happened, when, and why—if any explanations are available; (2) When AH detected the issue: A summary of when AH first found out about the issue, when we think it could have first found out about the issue, and when other organizations (such as the OIE, and industry sites (e.g., Intrafish, TheFishSite, FIS) first reported the issue; (3) Significance and Impact: A summary of the significance of the issue, its impact on aquaculture, the industry, and/or the environment. (Some of these issues have been reported in AH's Emerging Issues blog.)

3.1. Environment and Large Fish Population in Gladstone, Australia, 2011

The issue: Beginning in August 2011, dead and moribund barramundi (*Lates calcarifer*) were observed in the Gladstone area with red spots, cloudy eyes, and infected with an external parasite. At the time, the cause of these symptoms was unknown, and so Fisheries Queensland placed a temporary ban on all commercial, charter, and recreational fishing for 3 weeks (from 16 September to October 2011). An investigation confirmed a fungi, *Aphanomyces invadens*, better known as Epizootic Ulcerative Syndrome (EUS) in a single barramundi. The external parasite was identified as a monogenean, *Neobenedenia mellini*, which was responsible for the cloudy eyes. The health of barramundi in the Gladstone area improved over the following months and the last report of moribund barramundi with red lesions was on 18 May 2012.

The large scale dredging of Gladstone harbor (46 million tons over 20 years) began on 20 May 2011 in order to facilitate a \$70 billion port development to export Liquid Natural Gas (LNG). The area experienced severe flooding over the 2010/2011 summer and led to approximately 300 t of barramundi washing over the Awonga dam wall and into the Boyne River, which flows into the Gladstone harbor. This issue was further complicated by a concurrent outbreak of *Staphylococcus aureus*, which was found mainly in fisherman that had handled the moribund barramundi, and also by the unexplained deaths of 231 turtles, 10 dugongs and 6 dolphins in 2011 (reported on 18 October 2011). Gladstone harbor water quality parameters were being monitored prior to the first reports of moribund barramundi and they were found to resemble historical trends and within regulatory limits—although salinity was low due to the flooding.

When AH detected the issue: AH re-published a report on the barramundi issue on 31 August 2011. The original report was from the The Observer and described dead, blind and sick barramundi that had been observed in the Gladstone area and were being tested for a virus. Post-analysis of the issue returned an article published on 22 August 2011 in The Observer of a blind barramundi caught in the Calliope River, Gladstone, Australia. On 26 September 2011, reports were re-published by AH and ProMED confirming EUS on barramundi. These reports were not re-published by aquaculture industry websites.

Significance and Impact: Affected seafood retailers and commercial fisherman are seeking compensation for \$20 million from the Queensland government. The unhealthy appearance of the fish caught by commercial fisherman meant that they could not be sold at market, and this caused retail sales to go down 30%–40%, export markets to come to a halt, and for workers to be laid off.

3.2. Environment and Unregulated Aquaculture Cause Fish Deaths in Philippines 2011 and Ongoing

The issue: In the week prior to 25 May 2011, there were a series of mortalities in Taal Lake, Batangas, Philippines that culminated in an estimated loss of 2000 t of mostly farmed milk fish (*Chanos chanos*) and tilapia (*Oreochromis* spp.). The mortality of farmed fish in the many lakes of the Philippines occurs annually and usually at the end of the summer season. This mortality event is the largest since 2008, when 54 tons of milkfish died under similar conditions. The mortality of farmed milkfish and tilapia were reported again in 2012 from several lakes in the Philippines.

A hot 2010/2011 summer season ended in May 2011, a week prior to first reports of mortalities in 2011, when typhoon Chedeng passed through the region dumping heavy rain. The cool water from the

monsoon season runs off into the lake, sinks, and pushes warmer, oxygen-depleted waters up past the farmed fish. This natural phenomenon is locally termed “overtake” and can explain these seasonal mortalities. Investigation during this mortality event revealed low dissolved oxygen levels in the lake. Contributing to the impact of “overtake” were poor aquaculture practices that lead to overcapacity, overstocking and overfeeding that increased biological demand and lead to the high ammonium and nitrate levels recorded during this investigation.

When AH detected the issue: AH re-published a report on this issue on 25 May 2011. This report was published by GMA News Online on 25 May 2011 and initially alleged that local piggeries who were disposing their wastes in the lake were responsible for the mortality of fish in Taal Lake. These reports were not re-published either by OIE, ProMED or industry websites.

Significance and Impact: The massive fish kill in Taal Lake in May 2011 was estimated at 2000 tons of fish with an estimated total cost of PHP 190 million. This issue highlights the struggles of competing land use practices to provide food security and the unregulated aquaculture practices. Following this event, the Bureau of Fisheries and Aquatic Resources (BFAR) has planned to better regulate the aquaculture industry. For instance, within a few months following the incident, over 7000 illegally-operated fish cages in Taal Lake were dismantled by a multi-government task force in compliance with the environmental limit determined by scientific studies of six thousand fish cages in the lake.

3.3. Infectious Hematopoietic Necrosis Virus in Canada, 2012

The issue: Infectious Hematopoietic Necrosis Virus (IHNV) was detected on 14 May 2012 in Atlantic salmon (*Salmo salar*) submitted from a farm in Clayoquot Sound, British Columbia, Canada as part of the farm’s routine health monitoring program. IHNV then spread to neighboring farms extending south to Bainbridge Island, Washington State and north to Campbell River, British Columbia. All farms in BC were ordered by the Canadian Food Inspection Agency (CFIA) into quarantine and to depopulate. All active Atlantic salmon farms were tested for IHNV and all were reported to have returned negative results on 8 June 2012.

IHNV is endemic to the North West Pacific from Alaska to California. IHNV is usually sub-clinical in salmon species native to the Pacific area, but it can cause clinical disease and mortality in Atlantic salmon. This outbreak is speculated to have been caused by native sockeye salmon (*Oncorhynchus nerka*) migrating past these farms that were found to be infected by IHNV. These migrating salmon were determined to have a higher than average prevalence and intensity of the virus and genotyping studies found it closely resembled the strain common to sockeye from Washington State. It is unknown why these migrating salmon had a high virus load, although it is speculated that a high virus load is thought to cycle every 7 to 10 years. These fish were not vaccinated against IHNV, which increased their likelihood of becoming infected with this virus.

When AH detected the issue: AH re-published a report on this issue on 15 May 2012. This report was originally published in FIS (an industry website) on 16 May 2012 and stated that samples of Atlantic salmon tested positive for IHNV. ProMED re-published an article on 18 May 2012 confirming IHNV. OIE did not immediately report on the outbreak.

Significance and Impact: Farmed Atlantic salmon are highly susceptible to IHNV and are likely to have been infected from wild salmon with carrier status migrating past the farms. However, this was

the first outbreak of IHNV in BC since 2003. This issue demonstrates the importance of farm management practices and monitoring the health of wild fisheries populations that migrate past farms. CFIA has also established monthly reporting on its website of the detection of all federally reportable aquatic animal diseases.

3.4. *Emerging Shrimp Disease in South East Asia, 2009 and Ongoing*

The Issue: Shrimp began dying in China in 2009 from an unknown cause. These shrimp present with common symptoms including slow growth, corkscrew swimming, loose shells, pale coloration and an abnormal hepatopancreas. The cause of this mortality is commonly referred to as Early Mortality Syndrome (EMS) or Acute Hepatopancreatic Degenerative Necrotic Syndrome (AHDNS). This syndrome is highly lethal and devastating to the industry and is spreading. The aetiology of EMS is known to be caused by *Vibrio parahaemolyticus* infected with a phage that releases toxins (unpublished data).

When AH detected the issue: AH first re-published a report on EMS on 22 May 2011. This report was published in VNEconomyNews and reported that farmers in Mekong Delta were suffering from large scale shrimp mortalities across 40,000 hectares of farms. This article was re-published on fishupdate.com (industry website) on 3 June 2011. ProMED published a similar report on 10 June 2011. Network of Aquaculture Centres in Asia-Pacific (NACA) (a regional aquatic health group) issued a disease advisory for EMS/AHPNS on 23 May 2012; this was then picked up by AH and cited in the site's Emerging Issues blog. The syndrome was not reported by the OIE. An analysis of web content found a report suggesting of disease problems in China in 2010 [6].

Significance and Impact: This syndrome (now known to be caused by a pathogenic agent) is spreading rapidly. Since the first reported case of EMS in China in 2009, EMS has spread to Vietnam (2010), Malaysia (2011) and Thailand (2012). The first few reports published in AH detailed that in June 2011, provinces of the Mekong Delta suffered unprecedented losses with tiger shrimp in 40,000 hectares of farm area affected. Over 11,000 hectares of shrimp farms in Bac Lieu have been destroyed. In 6200 hectares of shrimp farms in In Tra Vinh, about 330 million shrimp have died causing a loss of over VND 12 billion. In Soc Trang, 20,000 out of 25,000 hectares of shrimp farms have been destroyed, causing VND1.5 trillion (US \$75 million) in losses.

On 15 and 16 July 2011 FAO specialists visited Vietnam to investigate the cause of shrimp mortality. AH created an Emerging Issues blog post [An emerging shrimp disease in Vietnam, microsporiosis or liver disease? (2010-ongoing)] on 24 February 2012. On 9 and 10 August 2012 NACA and DAFF convened an emergency consultation in Bangkok to deal with EMS and prevent it spreading further.

3.5. *Infectious Salmon Anaemia Virus in Eastern Canada, 2012*

The Issue: Infectious Salmon Anaemia Virus (ISAV) was detected on 09 February 2012 (outbreak 1) in Atlantic salmon from a farm in Shelburne Harbour, Nova Scotia, Canada as part of the farm's routine health monitoring and surveillance. Additional outbreaks of ISAV were reported on other farms in Nova Scotia on 12 June 2012 (outbreak 2) and Newfoundland on 19 June 2012 (outbreak 3) and 26 November 2012 (outbreak 4). All these farms were ordered by CFIA into

quarantine and undertake depopulation. New strains of ISAV were isolated from each of these 4 outbreaks. The two ISAV outbreaks in Newfoundland in 2012 represent a new geographical range. The closest geographical area to have previously reported ISAV is New Brunswick in 1996 and Nova Scotia in 2003. Of the 4 outbreaks, 3 were concurrent with Bacterial Kidney Disease (BKD).

When AH detected the issue: The first report on ISAV was re-published on 16 February 2012. This report was originally published in CBC News Nova Scotia on 17 February 2012 and stated that ISAV infection for Atlantic salmon was suspected from a farm in Nova Scotia. The Chronicle Herald published a report on 8 March 2012 to confirm infection of ISAV. ProMED re-published a report on 29 April 2012 confirming ISAV and the OIE provided an Immediate Notification for ISAV outbreak 1 on 12 March 2012. OIE provided Immediate Notification for an ISAV outbreak 2 on 11 July, an outbreak 3 on 9 July and an outbreak 4 on 19 December 2012. ISAV is a significant disease to the salmon industry and is well reported in ProMED and industry magazines.

Significance and Impact: In response to the detection of ISAV in four farms during 2012, the CFIA ordered the destruction of more than 1 million Atlantic salmon and paid compensation to these farms of more than \$30 million. This management practice for ISA by CFIA could be changing. CFIA have recently approved the sale of ISAV infected salmon for human consumption.

3.6. New Pancreatic Disease Variant in Norwegian Salmon, 2011

The Issue: Salmon Pancreas Disease Virus (SPDV) was detected on 30 November 2011 in Atlantic salmon from a farm in Nordmre, Norway as part of the farm's routine monitoring and surveillance. SPDV can lead to the clinical expression of Pancreatic Disease (PD). This is the first case of PD detected in Norway north of the Hustadvika line. The outbreak of PD was later confirmed to be caused by a new variant, SAV 2. The SAV 2 subtype has been detected in numerous farms from central to northern Norway. This SAV 2 subtype appears to be less lethal than the SAV 3 subtype, which is common in Norway.

Norway has managed PD with movement restriction between North and South geographical regions, split along the Hustadvika line. Until recently, this management practice seemed to be effective against PD, which had only been found in the South. The SAV 2 variant traditionally caused Sleeping Disease (SD) in rainbow trout and was first detected in Atlantic salmon in Scotland in 2008. Only about 25% of the fish stocked on the farm were vaccinated against PD.

When AH detected the issue: AH re-published report on PD on 6 December 2011. This report was published on 7 December 2011 in FIS and describes that PD was confirmed on 30 November 2011 but no external signs of disease or increase in mortality were evident. Post analysis revealed a similar report with the same details was published on 5 December 2011 by IntraFish. This first confirmation of SAV 2 variant was re-published by AH on 19 January 2012 from an article published in IntraFish on 20 January 2012. AH created an Emerging Issue blog "New Pancreatic Disease variant in Norwegian salmon" on 5 November 2012. This issue was not reported by either ProMED or the OIE.

Significance and Impact: The industry has questioned if this management is effective and has applied to change their management strategies for PD. New regulations have now been applied and involve monthly health checks and improved health and hygiene standards.

3.7. Used Aquaculture Equipment and OsHV-1 μ var, Australia 2010

The Issue: Oyster Herpes Virus type 1 micro-variant (OsHV-1 μ var) was associated with mass mortality of Pacific Oysters in France in 2008. This is a new variant of oyster herpes virus and has been detected and associated with mortality of Pacific Oysters in UK (2010), New Zealand (2010), Australia (2010), Netherlands (2011) and Spain (2011).

It is possible that this pathogen was always present in the environment. Alternatively, the pathogen could have spread through the unregulated movement of used aquaculture equipment, which is a widely recognized direct entry and exposure pathway for pests and diseases of concern for aquatic animals and the aquatic environment.

When AH detected the issue: AH re-published a report on this issue on 17 August 2010. This report was re-published by ProMED and published in National Geographic Daily News and described Pacific oysters had died on a farm in UK and were found infected with OsHV-1 μ var. The report also highlighted the farm had recently deployed equipment previously used in France to refurbish oyster beds. With respect to the Australian case, AH re-published a report on 7 January 2011. This was an Immediate Notification published on 7 January 2011 by the OIE for OsHV-1 μ var from Pacific oysters that had died on a farm in Botany Bay, Australia from 24 November 2010. A similar report was published on 12 January 2011 by The Fish Site. AH created an Emerging Issue blog “Oyster herpes OsHV-1 μ var goes global [2010–ongoing]” on 22 January 2012.

Significance and Impact: Although the emergence of aquatic animal diseases globally is multifactorial (associated with movement of stock, climate change, *etc.*), the role of used imported aquaculture equipment in disease spread had not previously been prominent. Interrogation of AH provided evidence of the unregulated movement of used aquaculture equipment, which is a widely recognized direct entry and exposure pathway for pests and diseases of concern for aquatic animals and the aquatic environment. Internet sites specializing in the online trade of aquaculture equipment, including used equipment, provide producers such as salmon farmers, abalone farmers or oyster farmers with an easy avenue to liquidate farm assets after their stock has been wiped out by disease.

As a result of the risk posed by the movement of used aquaculture equipment from disease-affected areas overseas, within weeks of the threat becoming recognized, the Australian Government introduced preventive measures to ensure that all used equipment exported to Australia is decontaminated on arrival (DAFF 2010).

3.8. Amoebic Gill Disease in Scotland, Ireland and Norway, 2012

The Issue: Amoebic Gill Disease (AGD) was first recognized outside of Tasmania, Australia, in Atlantic salmon in Norway in 2006. AGD has now caused mortality of Atlantic salmon in Ireland (2010) and Scotland (2011).

AGD is caused by the protozoan amoeba, *Neoparamoeba perurans*, and has been a major problem in the Tasmanian salmon industry for the last 20 years. Gill diseases are prominent throughout the Atlantic salmon industries of Ireland, Scotland and Norway. However, in recent years AGD has become more prominent in the cause of gill disease.

When AH detected the issue: AH re-published a report on AGD on 20 February 2012. This report was published on 20 February 2012 by TheFishSite and described AGD was first detected in Ireland

during summer of 2010 and Scotland in September 2011. Neither ProMED or the OIE have published reports for AGD. AH created an Emerging Issues blog on 16 October 2012 titled “Amoebic gill disease in Scotland (2011 and ongoing)”.

Significance and Impact: The same protozoan causing AGD in Tasmania has now emerged as a potential problem in Norway, Ireland and Scotland. A vaccine is being developed for AGD. A vaccine may limit the impact of AGD on these European industries.

4. Forecasts

Based on the information gathered by AquaticHealth.net, and based on some of the trends and events identified in Section 3, it may be possible to forecast future significant events in aquaculture. In this section, we document some salient such possibilities, with their rationales.

4.1. Marine Finfish Disease in South East Asia. Water Quality in the Philippines

The seasonal mortality of farmed tilapia and milkfish in lakes of the Philippines is likely to persist for several more seasons. This issue is centered on “overturn”, a natural phenomenon that occurs at the onset of the monsoon season. The impact of “overturn” to aquaculture is greatly influenced by aquaculture management practices. The Bureau of Fisheries and Aquatic Resources are aware of and have policy to regulate aquaculture and limit the impact of overturn to aquaculture. However, it must be recognized that regulation is difficult because of the importance of food security to the local communities. BFAR are improving aquaculture practices through teaching farmers and by monitoring environmental conditions to provide warning to farmers of imminent overturn conditions.

Continuation of these conditions caused by “overturn” and high density aquaculture are likely to encourage disease outbreaks. A disease that could emerge is a Streptococcus-type bacterium or a novel virus. Tilapia has been a disease hardy aquaculture species. AH has published reports on vaccine for Tilapia against Streptococcus in Indonesia and identification of a new virus infecting and causing disease in Tilapia in Israel, which is speculated to have been present for last 10 years and cause of decline in fishery in Lake Kinnet, Israel.

4.2. Emerging Shrimp Disease, Vietnam. EMS in Prawns

AH created an Emerging Issue blog on 24 February 2012 titled “An emerging shrimp disease in Vietnam, microsporiosis or liver disease? (2010 and ongoing)”. On 16 January 2013, AH speculated that EMS will spread to Indonesia in the first month or two of 2013 growing season if it isn’t already there in Indonesia.

The aetiology for EMS had not been identified at the time. This made it difficult to manage at the farm level and the implementation of biosecurity measures at the country level. It is likely that EMS will continue to spread and affect many more countries. Indonesia sources 90% broodstock from China. If the agent is environmental and found in the wild, then ocean currents could spread it to Indonesia.

4.3. Amoebic Gill Disease to Spread in Scandinavia. AGD in Salmon

AH created an Emerging Issue blog on 16 October 2012 entitled “Amoebic gill disease in Scotland (2011 and ongoing)”. A forecast was made on October 2012 that it is only a matter of time before AGD becomes a major problem in Norway.

AGD has been a huge problem in the Atlantic salmon industry in Tasmania, Australia for over 20 years. The appearance of AGD in Norway (2006), Ireland (2010) and Scotland (2011) after so many years confined to Tasmania could indicate that spread is contingent on irregular events. AGD is caused by infection with *Neoparamoeba perurans*. In the wild, this pathogen can be carried by oceanic currents.

4.4. OsHV in Australia. OsHV in Oysters

AH created an Emerging Issues blog on 22 January 2012 entitled “Oyster herpes OsHV-1 μ var goes global [2010–ongoing]”. OsHV-1 μ var is likely to be detected in Brisbane Water, Hunter River and Port Stephens in the next few years.

OsHV-1 μ var was detected in Australia in the Georges River and Parramatta River (2010) and Hawkesbury River (2013) after a mass mortality event of farmed Pacific oysters. The appearance of this virus in the Hawkesbury River three years after its first appearance in Australia has demonstrated its capacity to spread. Industry in Georges and Hawkesbury River are based on Pacific oyster, are new and less than 4 years old, and were previously based on Sydney rock oyster prior to outbreak of QX disease, which wiped the industry out. This change in industry species incurs a change in management practices and there is less translocation of oysters between ports (It is unlikely that oysters are translocated into or out of Georges and Hawkesbury). Therefore, it is speculated that translocation of oysters is less critical for spread of this virus. More important routes of spread may include: natural water currents or movement of recreational vessels, or disease may have originated from a common source and is now expressing, or is a hatchery disease.

5. Conclusion

AquaticHealth.net is an example of what can be achieved in today’s technologically democratized world. In its short history, AquaticHealth.net has been used to capture emerging disease information, analyze and track disease trends, map diseases, organize data, perform basic forecasting, contribute to future health planning, provide biosecurity alerts, build biosecurity risk profiles and support responsive decision-making relating to imports and exports. In this paper, we have documented some of these results over the last 2 years, and we have identified what we believe to be realistic forecasts for the future. Time will tell whether these forecasts are accurate, and as events resolve, AquaticHealth.net will learn from them and improve its forecasting methods.

References

1. Lyon, A.; Grossel, G.; Burgman, M.; Nunn, M. Using internet intelligence to manage biosecurity risks: A case study for aquatic animal health. *Divers. Distrib.* **2013**, in press.

2. Brownstein, J.S.; Freifeld, C.C.; Madoff, L.C. Digital disease detection—Harnessing the Web for public health surveillance. *New Engl. J. Med.* **2009**, *360*, 2153–2157.
3. Chalmers, D. The Singularity: A Philosophical Analysis. *J. Conscious. Stud.* **2010**, *17*, 7–65.
4. Floridi, L. Web 2.0 vs. the Semantic Web: A philosophical assessment. *Episteme* **2009**, *6*, 25–37.
5. Grossel, G.; Lyon, A.; Nunn, M. *Open-Intelligence Gathering and Analysis for Biosecurity, Risk-Based Decisions for Biological Threats*; Walshe, T., Ed.; Cambridge University Press: Cambridge, UK, 2013.
6. China Shrimp Report details problems of 2010, says demand for imported shrimp will continue in 2011. Available online: http://033a4a2.netsolhost.com/news_details.php?news_id=8 (accessed on 04 March 2011).

© 2013 by the authors; licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution license (<http://creativecommons.org/licenses/by/3.0/>).