Aquatic Animal Disease Surveillance

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AusVet Animal Health Services
Overview

- Introduction
- Characteristics of surveillance systems
- Approaches to surveillance
- Risk-based surveillance
- Evidence of freedom
- Output-based regulation
Introduction
White Spot Virus Detection Kit

Detection by Single Tube
Nested DNA Amplification
For 100 Detections
Expiration Date:
For Research Use Only
Storage: -20°C

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• Diagnostics
  ▫ More than having the right reagents

• Surveillance
  ▫ More than knowing the right sample size
EpiTools epidemiological calculators

This site has been developed by [AusVet Animal Health Services](http://www.ausvet.com.au), with funding from the [Australian Biosecurity Cooperative Research Centre](http://www.crc.org.au). The site is intended for use by CRC members and other epidemiologists and researchers involved in estimating disease prevalence or demonstrating freedom from disease through structured surveys, or in other epidemiological applications.

Site Contents

- **Survey Toolbox for livestock diseases and freedom in finite populations**
- **HerdPlus module for herd-sensitivity and freedom in finite populations**
- **Detection of disease or demonstration of freedom**
- **2-Stage surveys for demonstrating disease freedom**
- **Application or evaluation of diagnostic tests**
- **Sample size calculations**
- **Summarise categorical or continuous data**
- **Estimating true prevalence**
- **Pooled prevalence calculator**
- **Statistical significance testing**
- **Probability distributions**


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Surveillance and Biosecurity

- **Biosecurity**
  - Requires many decisions

- **Epidemiology**
  - Tools for decision-making in the presence of uncertainty

- **Surveillance**
  - Branch of epidemiology
  - Gather the right information to help make the right decisions
  - Information is never perfect
  - Aim is to make the right decisions most of the time
Examples

- What is the best source of seed stock (to avoid introduction of infection)?
  - Status of sources
- What is the risk of introduction of different diseases?
  - Prevalence and distribution
- How do I know if a new disease has appeared and poses a new threat?
  - Early warning
Characteristics of surveillance systems
Characteristics of surveillance

- I want to buy a car
- Which one should I get?
Characteristics

• Current status with respect to the disease
• Purpose of the surveillance
• Origin of the information
• Disease focus
• Population coverage
• Representativeness
• Type of data collected
• Quality
• Others
• Surveillance approach
Current status

• Present
•Absent
Purpose of the surveillance

• Present
  ▫ Measuring the occurrence or distribution of disease
    • Baseline studies
    • Priority setting
    • Risk analysis
  ▫ Monitoring progress of control programs over time
    • Confirm effectiveness
    • Early intervention if not working

• Absent
  ▫ Demonstrate freedom
    • Support safe movement at lot, farm, zone or national level
  ▫ Early warning
    • Exotic or emerging diseases
Origin of the data

- **Active**
  - Primary purpose of data collection is surveillance
    - Group running the surveillance has control over design and data
    - Data meets the needs of surveillance
    - Expensive

- **Passive**
  - Surveillance is a secondary use of data collected for different primary purpose
    - Disease reports – seeking assistance to resolve problem
    - Drug sales – accounting
    - Production records – farm management
Disease focus

- **Targeted**
  - Focused on a specific disease

- **General**
  - Able to detect any disease
    - including previously unknown diseases

- Normally determined by the type of test used
  - **Targeted**
    - Agent-specific tests (eg PCR)
  - **General**
    - Clinical examination, post-mortem, histology
    - Syndromic, indirect, anomaly detection
Population coverage

• Census
  ▫ All animals

• Sample
  ▫ Proportion of the population
    • Small or large proportion
    • Distribution of sample
Representativeness

• **Representative**
  ▫ Characteristics in the sample are similar to those in the population
  ▫ Normally achieved by random sampling

• **Non-representative**
  ▫ Characteristics are systematically different to the population
    • Bias
    • Risk-based surveillance

• Both may be useful for different purposes
Type of data collected

- Diagnoses
  - Investigations
- Classifications
  - Screening test results
    - Disease state
    - Immune or risk status
- Syndromes, signs
  - Morts, swimmers
- Indirect indicators of disease
  - Feed consumption
- Negative reports
- Risk factors
  - Algal monitoring programs
Quality

- Diseases that are present
  - Main result: prevalence (and others)
  - Quality measures: Precision and accuracy
  - Systematic and random error
Quality (2)

• Diseases that are absent
  ▫ Main result: yes / no
  ▫ Quality measure: Sensitivity
    • Probability that the surveillance system would detect at least one positive animal / farm if the disease is present at a specified level (the design prevalence)
Other characteristics

- Form of data collected
- Recording and communication systems
- Cost / efficiency
- Practicality
- Timeliness
- Fitness for purpose
Approaches to surveillance
Surveillance approaches

- Passive disease reporting system
- Structured surveys
- Sentinel surveillance
- Proxy surveillance
- Risk-factor surveillance
- Indirect surveillance
- Syndromic surveillance
- Participatory disease surveillance
- Post-harvest processing
2. The risk-based animal health surveillance scheme referred to in paragraph 1 shall aim at the detection of:
(a) any **increased mortality** in all farms and mollusc farming areas as appropriate for the type of production;

**Risk-based approach**
- Relative risk: 8
- High risk: 10% of animals, 80% prevalence
- Low risk: 90% of animals, 10% prevalence
- True prevalence: 17%
- Apparent prevalence: 80%
Early warning, new diseases

- General surveillance
- High coverage
- Timely
- Surveillance options?
  - Passive farmer reporting
  - Indirect surveillance
    - Feed consumption
  - Syndromic surveillance
    - Morts
  - Incentives?
Analysis of disProgObj using cusum: anscombe

No. infected

2001 2002 2003 2004 2005 2006 2007 2008
II II IV I III II I IV III

Infected
Upperbound
Alarm
Outbreak

AusVet
Animal Health Services
Risk-based surveillance
Article 10

Animal health surveillance scheme

1. Member States shall ensure that a risk-based animal health surveillance scheme is applied in all farms and mollusc farming areas, as appropriate for the type of production.

2. The risk-based animal health surveillance scheme referred to in paragraph 1 shall aim at the detection of:

(a) any increased mortality in all farms and mollusc farming areas as appropriate for the type of production;

(b) the diseases listed in Part II of Annex IV, in farms and mollusc farming areas were species susceptible to those diseases are present.
Risk-based surveillance (1)

- **Theory – easy**
  - Look for disease where it is most likely to be
  - Cheaper, more efficient
  - Small sample, same sensitivity

- **Practice – a bit more complicated**
  - What does risk mean?
  - When do we apply it?
  - How do we quantify the sample size?
  - Other sampling issues
Definitions of “risk”

1. Likelihood of an adverse event
   - The risk of being killed in a plane crash is less than the risk of being killed in a car accident
   - Relative risk

2. Likelihood and consequences
   - Risk analysis definition

3. Risk-based surveillance
   - Does it include consequence or not?
Risk-based surveillance (2)

• Surveillance in fish, single risk factor
  ▫ Example of risk factors
    • Water temperature, age (influence disease)
    • Moribund, lesions (caused by disease)

• To quantify benefit of risk-based sampling, need
  ▫ What is the difference in risk?
    • Describe with relative risk
  ▫ How has the higher risk population been targeted
    • Proportion in the population
    • Proportion in the sample
Risk-based surveillance - Example (1)

- **High risk group**
  - Relative risk: 3
  - Proportion of population: 20%

- **Other parameters**
  - Design prevalence: 1%
  - Test sensitivity: 90%
  - Target surveillance sensitivity: 95%
Example: relative risk = 3

<table>
<thead>
<tr>
<th>Scheme</th>
<th>High risk</th>
<th>Low risk</th>
<th>Sample size (% saving)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Representative</td>
<td>20</td>
<td>80</td>
<td>331 (0)</td>
</tr>
<tr>
<td>Risk based</td>
<td>50</td>
<td>50</td>
<td>231 (30)</td>
</tr>
<tr>
<td>Risk based</td>
<td>90</td>
<td>10</td>
<td>165 (50)</td>
</tr>
<tr>
<td>Biased</td>
<td>10</td>
<td>90</td>
<td>387 (-17)</td>
</tr>
</tbody>
</table>
Example: relative risk = 1.5

<table>
<thead>
<tr>
<th>Scheme</th>
<th>High risk</th>
<th>Low risk</th>
<th>Sample size (% saving)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Representative</td>
<td>20</td>
<td>80</td>
<td>331 (0)</td>
</tr>
<tr>
<td>Risk based</td>
<td>50</td>
<td>50</td>
<td>291 (12)</td>
</tr>
<tr>
<td>Risk based</td>
<td>90</td>
<td>10</td>
<td>251 (24)</td>
</tr>
<tr>
<td>Biased</td>
<td>10</td>
<td>90</td>
<td>347 (-5)</td>
</tr>
</tbody>
</table>
Proportion in high risk group
Evidence for freedom
Evidence of freedom
Introduction of infection
Survelliance sensitivity

Biosecurity Measures

Probability of Freedom

Surveillance sensitivity
Output-based regulations
**Inspection and sampling scheme for zones and for farms in non-approved zones for the two-year control period which precedes achievement of approved status for VHS and/or IHN**


<table>
<thead>
<tr>
<th></th>
<th>Number of clinical inspections per year (two years)</th>
<th>Number of laboratory examinations per year (two years)</th>
<th>Laboratory examination for presence of virus (*)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Number of growing fish (Organ material)</td>
</tr>
<tr>
<td>Continental zones and farms</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(a) Farms with broodstock</td>
<td>2</td>
<td>2</td>
<td>120 (first inspection) (²)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>150 (second inspection)</td>
</tr>
<tr>
<td>(b) Farms with broodstock only</td>
<td>2</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>(c) Farms without broodstock</td>
<td>2</td>
<td>2</td>
<td>150 (first and second inspections)</td>
</tr>
</tbody>
</table>
Output-based standards

Examination, sampling, testing and diagnosis of aquaculture animals

1. The examination, sampling, testing and diagnosis of aquaculture animals shall be carried out ensuring that the environmental conditions conducive to the laboratorial detection of the relevant listed disease(s) are present in the quarantine facility during the whole quarantine period.

2. During quarantine, the following aquaculture animals shall be sampled within 15 days before date of the expiry of the quarantine period:

   (a) when sentinel aquaculture animals are used, samples from all of them must be taken;

   (b) when sentinel aquaculture animals are not used, samples must be taken from a relevant number of aquaculture animals ensuring the detection of the relevant listed disease(s) with a 95% confidence if the design prevalence is 10% (never less than 10 animals).

- Doesn’t take risk into account
Preferred output-based standard

- **Probability of freedom**
  - Flexibility
    - Choice of tests
    - Approach to surveillance
    - Number of animals tested
    - Frequency of testing
  - Accounts for biosecurity
    - Probability of introduction of infection
Surveillance sensitivity

Sample size
Risk-based sampling
Diagnostic test Se
Multiple surveillance

Probability of freedom

Historical surveillance

Risk of introduction

Consequence of disease

Target standard

Fomites
Water
Live fish

Probability of freedom

Historical surveillance

Risk of introduction

Consequence of disease

Target standard

Fomites
Water
Live fish
Sensitivity

Farm

0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9

1 2 3 4 5 6 7

From Sensitivity
Sensitivity

Farm

1 2 3 4 5 6 7
Less surveillance = save money

More surveillance = prevent disease
Conclusions
Conclusions - Risk-based surveillance

- Risk-based surveillance
  - Relative risk of infection in sub-groups within a population under surveillance
- Probability of introduction of infection
  - Influences how much surveillance is needed
  - Good biosecurity, less surveillance over time
- Consequences of being infected
  - Influences standard of proof of freedom required
  - High consequences, meet higher standard
Conclusions

• Greatly improved understanding and much new research in surveillance in last few decades
• An exciting variety of surveillance options
  ▫ Less expensive
  ▫ Better suited to different situations
• New approaches tend to be more complex
  ▫ Easier to make mistakes
  ▫ Need professional guidance to take advantage of new opportunities
Notices

• Course in analysis of surveillance data
  ▫ Prince Edward Island, Canada, 5\(^{\text{th}}\) to 9\(^{\text{th}}\) October

• Species networking
  ▫ Crustaceans, molluscs