Food and Agriculture Organization of the United Nations

Presentation

Aquatic Animal Disease surveillance: objectives, principles and determinants

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FAO/ASTF Project: GCP/RAF/510/MUL:

Enhancing capacity/risk reduction of emerging Tilapia Lake Virus (TiLV) to African tilapia aquaculture: Intensive Training Course on TiLV

4-13 December 2018. Kisumu, Kenya

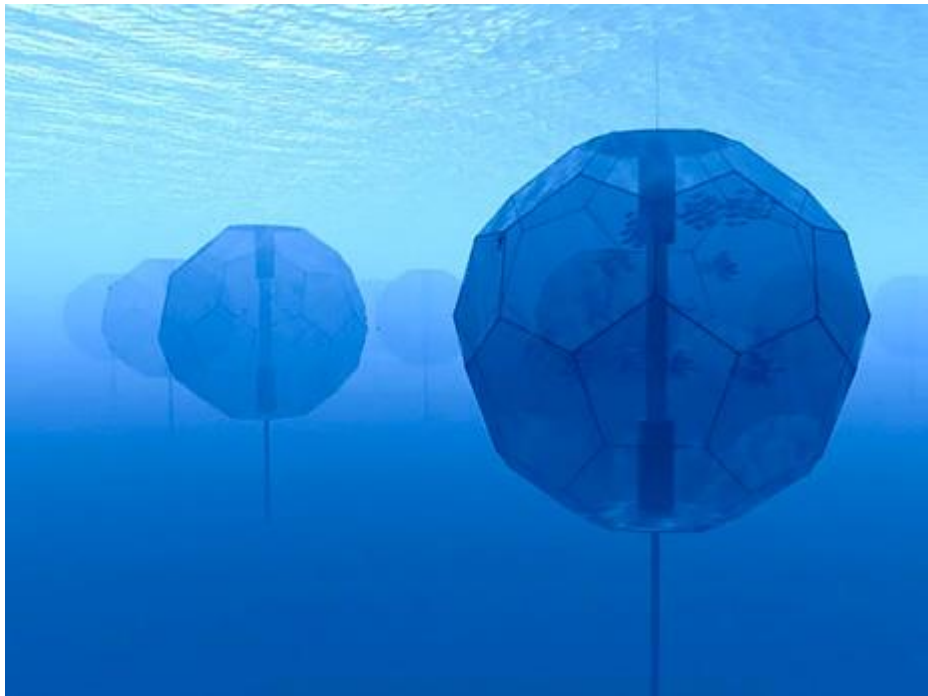
in cooperation with Kenya Marine Fisheries Research Institute (KMFRI) and Kenya Fisheries Service (KeFS)

Presentation outline

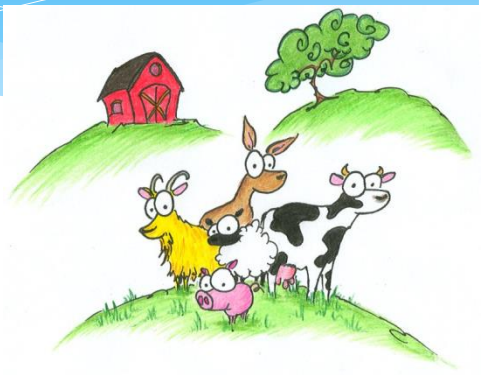
* Key challenges of AAD surveillance comparing to surveillance of terrestrial animal diseases
* Objective of AAD surveillance
* Key determinants of AAD surveillance
* Surveillance plan and implementation

Aquatic vs. Terrestrial surveillance

* **Challenge 1 – Environment**
  * Terrestrial sp. – housing, ventilation, lighting, feed and feed distribution, water
  * Aquatic sp. – water is all
    * Fresh water, salt water
    * Still water bodies, rivers
    * Density



Aquatic vs. Terrestrial surveillance



* **Challenge 2 – Biology of host**
* Most terrestrial animals
  * Warm blood
  * Vertebrate
  * Mammals
  * Containment and biosecurity (movement, housing)
* Aquatic animals (and plants!)
  * Cold blood
  * Many invertebrates
  * Fish, crustaceans, mollusks
  * Farming integrated into environment

Aquatic vs. Terrestrial surveillance

* **Challenge 3 – diversity of pathogens**

Aquatic Animal Health Code

PDF

CHAPTER 1.3.

DISEASES LISTED BY THE OIE

Preamble: The following *diseases* are listed by the OIE according to the criteria for listing an *aquatic animaldisease* (see Article 1.2.1.) or criteria for listing an *emergingaquatic animaldisease* (see Article 1.2.2.).

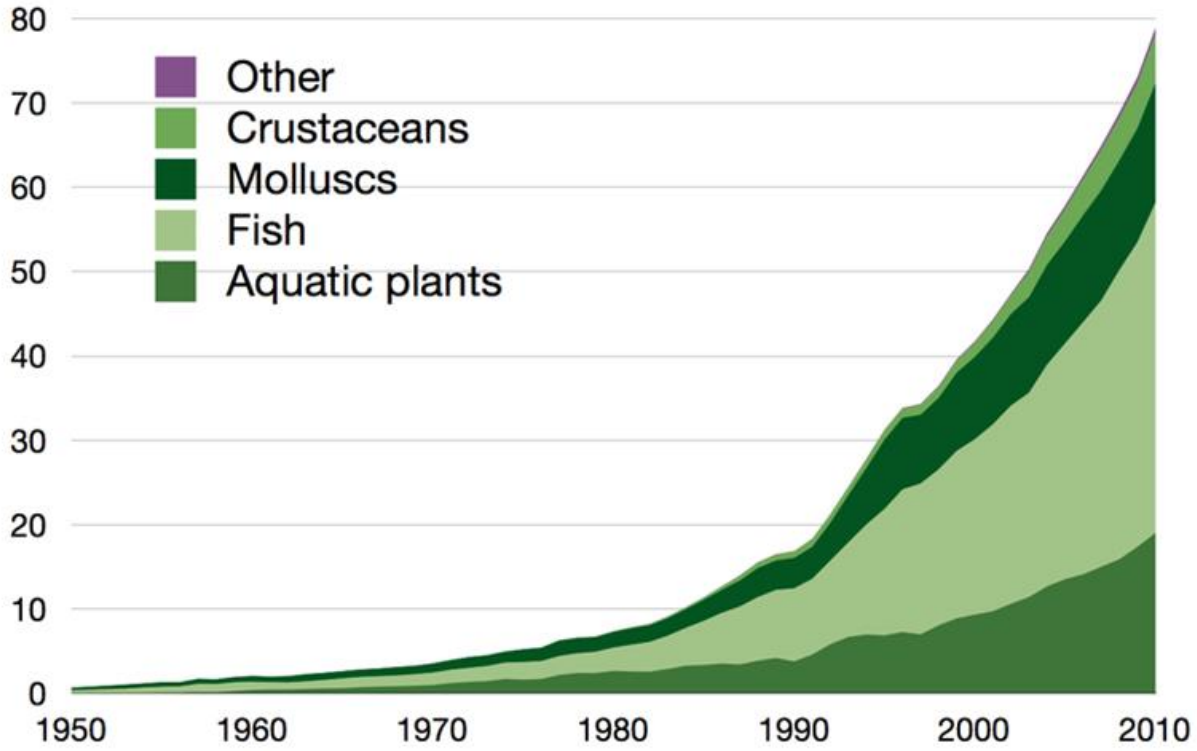
In case of modifications of this list of *aquatic animaldiseases* adopted by the World Assembly of Delegates, the new list comes into force on 1 January of the following year.

Article 1.3.1.

Aquatic vs. Terrestrial surveillance

- **Challenge 4– diversity of management systems**
  - Extensive systems
    - cages, still water ponds/reservoirs
    - *Tilapines,* catfish, *Cyprinids*
  - Semi-intensive systems
    - the ponds are fertilized
    - Exogenous feeding
  - Intensive systems
    - water flows in and out continuously
    - higher stocking densities
    - complete feeds and water aeration
- Integrated Multi-species Aquaculture

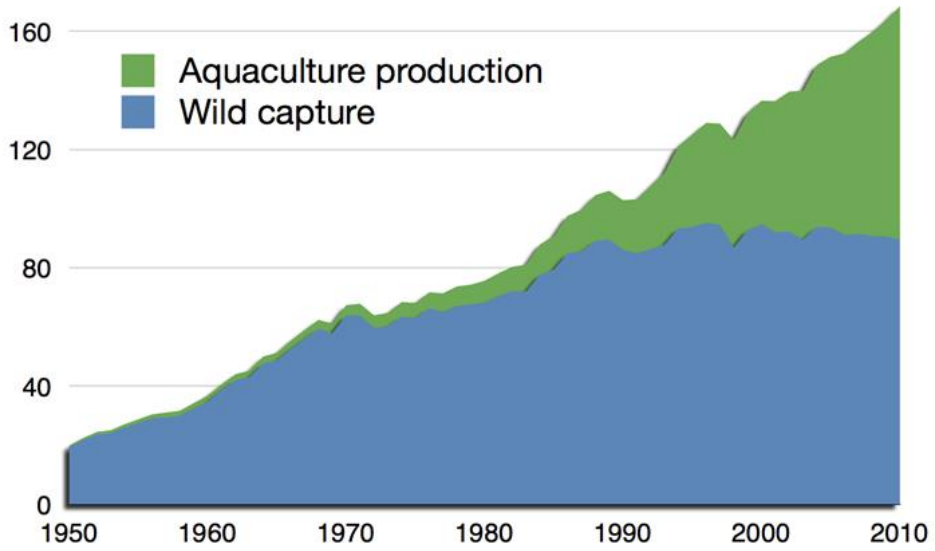
Aquatic vs. Terrestrial surveillance



* Rapid growth

Aquatic vs. Terrestrial surveillance

* Aquaculture seeks to replace wild capture
* Farming of piscivorous fish (salmon) – still requires other fish as feed



In summary: key challenges for surveillance planning for AAD

* Animals are kept in water
* Often in complex rearing system
* The size of the fish population on farm
* Accessibility for inspecting and sampling animals
* Some basic information relevant to planning such as expected prevalence in infected population and diagnostic test performance is often limited or not available

Principles of AAD surveillance

* Should be tailored designed
  * wide variety of species cultured, the pathogens and management systems
* Support to domestic production
* Tool to promote international trade (international disease reporting, OIE standards)
* Moving toward Output based approaches

Objective of AAD surveillance

* Objective of AAD surveillance
  * Dependent from disease presence/absence
  * Dependent from certification level (farm/region/country)
* **Disease present**
  * Reliably measure disease frequency/trends
  * Make corrective actions
  * Monitor effectiveness of DCP
* **Disease absent**
  * Demonstrate disease freedom
  * Early detection of disease

Objective of AAD surveillance

* Different certification level
  * **Farm accreditation/certification**
  * **National/regional disease free status**
* Monitoring of diseases in environment
* May target specific disease
* May include multiple diseases (even previously unknown/unseen)

Principles of AAD surveillance

PDF

CHAPTER 1.4.

AQUATIC ANIMAL HEALTH SURVEILLANCE

Article 1.4.1.

Introduction and objectives

Surveillance activities may be performed to achieve any of the following objectives:

a. demonstrating the absence of *disease*;

b. identifying events requiring *notification* as listed in Article 1.1.3. of the *Aquatic Code*;

c. determining the occurrence or distribution of endemic disease, including changes to their *incidence* or *prevalence* (or its contributing factors), in order to:

   i. provide information for domestic *disease* control programmes,

   ii. provide relevant *disease* occurrence information to be used by trading partners for qualitative and quantitative *risk assessment*.

Disease notification (OIE)

* Immediate notification (whithin 24 hours)
  * First occurence or re-occurence of OIE listed diseases
  * First occurence in new host species
  * New disease manifestation or new pathogen strain
  * With newly recognised zoonotic potential
  * Non listed diseases if could have epidemiological significance
* Wekly reports (after immediate notification)
* Six monthly report
* Annual questionnaire

Objective of AAD surveillance

Surveillance **to demonstrate freedom** from disease

- On-going evidence
- Certification for zones, regions and compartments
- Threshold set by design prevalence
- No single survey is enough

Objective of AAD surveillance

Surveillance **for distribution and occurrence** of disease:

* Prevalence and incidence
* Morbidity and mortality
* Risk factors
* Differences between epi units
* Days from confirmation to control actions
* Farm production records

Principles of AAD surveillance

4. It would be impractical to try to develop a *surveillance* system for all the known *aquatic animaldiseases* for which a country has *susceptible species*. Therefore prioritising the *diseases* to be included in a *surveillance* system should be conducted considering:

   a. the needs to provide assurance of disease status for trade purposes;

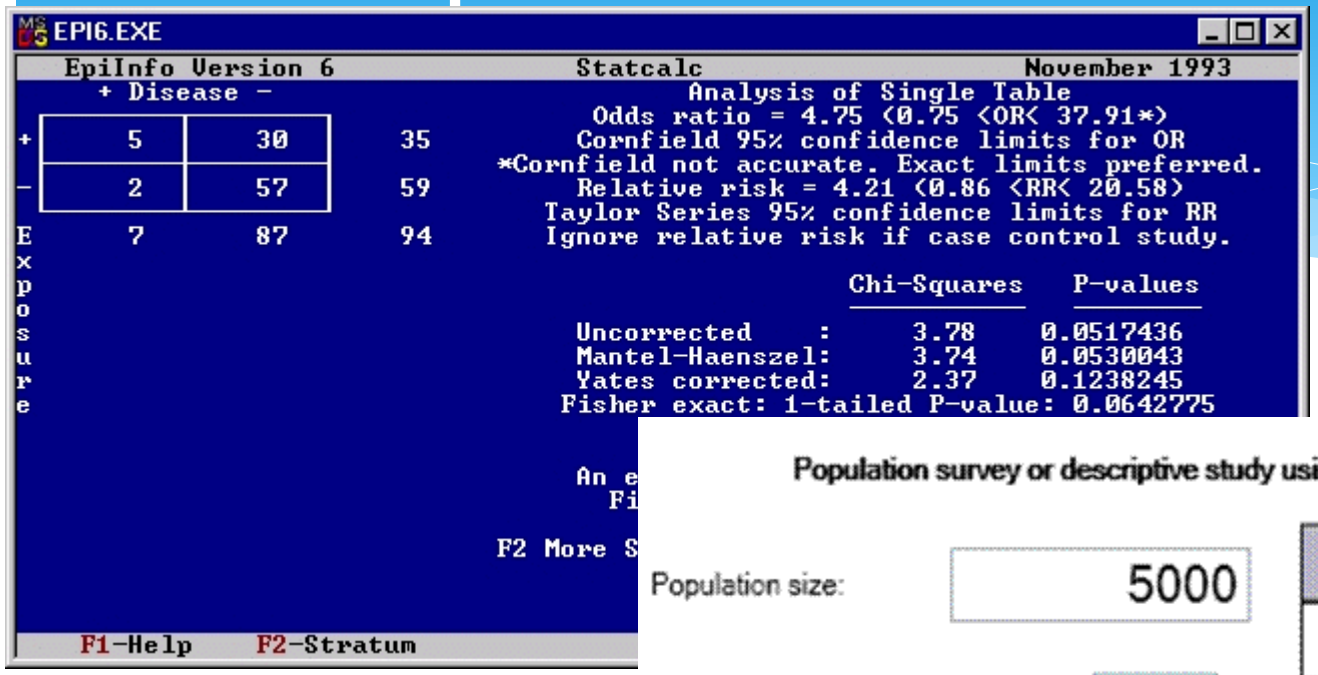
   b. the resources of the country;

   c. the financial impact or threat posed by the different *diseases*;

   d. the importance of an industry-wide *disease* control programme within a country or region.

Principles of AAD surveillance

Principles of AAD surveillance



Population survey or descriptive study using random (not cluster) sampling

Population size: 5000

Expected frequency: 10 %

Confidence limits: 6 %

Confidence Level	Sample Size
80%	41
90%	67
95%	94
97%	115
99%	161
99.9%	257
99.99%	352

Key determinants of AAD surveillance

1. Definition of population
2. Documentation of methodology, study design and analysis
3. Clustering
4. Design prevalence
5. Test characteristic
6. Sampling
7. Quality assurance systems

Population

* Proper consideration of population provides authority with the flexibility to design **well- targeted surveillance system.**
* The **target population** to which the surveillance applies is all individuals of all species susceptible to the infection in the country or zone
* Whenever the **study population** (individuals selected to participate in study) is different from the target population, there is a risk that the findings from the study population may not represent the true situation.

Population

* Single or mixed species
* Separation (strata) by species
* Separation (strata) by size and age
* Aquatic animal population are often considered infinite for the purpose of sample size calculation
* Difficulties in access to and visibility of aquaculture fish mean that disease problems may not be noticed immediately
* Collecting of moribund or newly dead fish essential for good surveillance

Study population should be:

* As defined in the relevant disease chapter of the OIE Code, where exists;
* A subset of target population defined by:
  * Species
  * Time, season or month of year
  * Stage of life cycle
  * Production/management system
  * Location

Population

* Whatever the study population used, it is most important **to document it**, to consider how it differs from the target population, to account for any effects.
* Target population for TiLV in participating countries?
* Describe farming system, farm registration data, approval of farms, if exist
* Wild fish population

Metodology, survey design and analysis

* Structured surveys for both exotic and endemic diseases
  * Designed based on hypothesis testing (i.e. Disease frequency = 0, or < designed prevalence)
  * Designed base on estimation of population parameters
* Surveillance ≠ survey

Statistical inference

* Hypothesis testing and estimation of parameters
* Proving disease absence – never with 100%
* Probabilistic approach
  * i.e. Acceptable probability that surveillance system will detect disease at designed prevalence
* Output of any (statistical) method used must be the same: a measure of the confidence that the survey would have detected disease if it were present at specified level

* **Null hypotesis: disease is present** at a level equal to or grater than that specified by the design prevalence
* If we reject null hypotesis and accept **alternative hypotesis disease is not present** at the level equal to or greater then that specified by the design prevalence.
* **The required level of confidence** in the surveillance system must be greater than or equal to **95 %**

* **Reject Ho= disaease free**
* Probability of rejecting true null hypothesis = alfa (α) (disease present country declare free)
* Consequence: the spread of infection between countries
* 1-α = strength of evidence confirming null hypothesis – measure of confidence ≥95% (account for test characteristics)

* **Accept false Ho**: country determines infected, in fact free (type II error)
* **Power** of the analysis is probability of avoiding a type II error
* No international standards
* Consequence: loss of trade opportunity, however no increased risk for spreading of disease, more samples
* In practice, many test system involve one confirmatory testthat is considered for all intents and purposes to have a specificity of 100 %

The design of survey

Will depend on the size and and structure of the population being studied:

- **Single stage survey** (individual animals)
  - Certification of batches of animals for export
  - Certification of single establishment (one pond/cage)
- **Stratified (multistage) surveys**: ponds, farms or villages
  - By species
  - By region
  - By production type
  - Allows multiple sampling methods to account for differences

Analysis of results:

* Account for **survey design**
* Account for **diagnostic test imperfection**
* Account for **design prevalence(s)**

Design prevalence (DP)

* Design prevalence **is not** diseasae prevalence
* It form part of definition of the null hypotesis
* It is abstract statement of what may be present in nature
* Design prevalence: minimum expected prevalence, maximum acceptable prevalence, minimum detectable prevalence

Design prevalence (DP)

* The OIE code for terrestrial animals provide DP and detailed guidance for surveillance specific to several of the listed diseases
* In the Aquatic animal health code only general recommendations are provided
* In the absence of specific requirements for specific disease, the DP needs to be set applying the guidance in the Aquatic code

Design prevalence (DP)

* At the individual animal level, the DP should be based on the biology of the infection
* A suitable DP value at the animal level may be
  * 1% - 5 % for infections that are transmitted slowly
  * Over 5 % for more contagiuos infections
* At higher levels (cage, pond, farm, village, etc) the DP usually reflect the prevalence of infection that is practically and reasonably able to be detected by a surveillance system.
* A suitable DP prevalence value for the first level of clustering (e.g. Proportion of infected farms in a zone) may be up to 2%

More about data collection

Collect all data you need, use all data you collected!!!

- Methods of data collection
  - Active
    - Primary purposes of surveillance activities
    - Data tailored to surveillance needs
    - Population based surveys (at slaughter or live animals)
    - Expensive
  - Passive
    - Surveillance uses data from other sources (drug use, farm records, laboratory, market etc.)
    - May lack representativeness, completeness, timing

* In addition to disease diagnosis data
  * Epidemiology of disease
  * Movement of animals (cultured and wild)
  * History of trade/import
  * Compliance with health regulation

* ALL DATA SOURCES SHOULD BE DESCRIBED!!!

* Sources of data for AAD surveillance
  * Laboratory databases
  * Field reporting system
  * Negative reporting system
  * Production records
  * STRUCTURED SURVEYS!!!

Clustering

* Diseases usually cluster rather then being uniformlyor randomly distributed through a population
* Clustering may occur in:
  * space (tank, pond, farm, compartment)
  * Time (Season)
  * Animal subgroups (age, physiological condition)

Sampling

* Why different sampling methods?
* Farm management
  * Size of groups/pools?
  * With/without broodstock?
* Feasibility
  * Ensure randomness
  * Identify all animals/groups/farms
  * Access to all animals/groups/farms
* Disease biology
  * Infectious vs. Noninfectious diseases

Sampling plan

* Identification of sampling unit
* Selection of sampling methods
* Sample size (representative of population)

Sampling

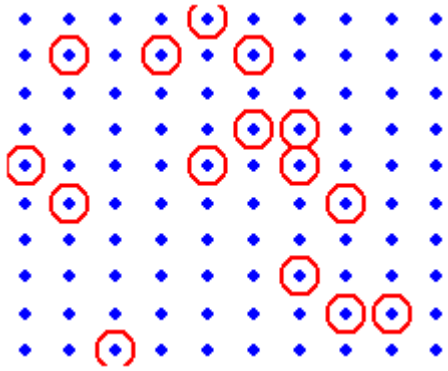
* Probablity based sampling (data from the study population can be extrapolated to the target population a statistically valid manner)
* Non - probability based sampling (convenience, expert choice, quota)
* In any case, the sampling method used at all stages should be fully documented and justified.

Random sampling

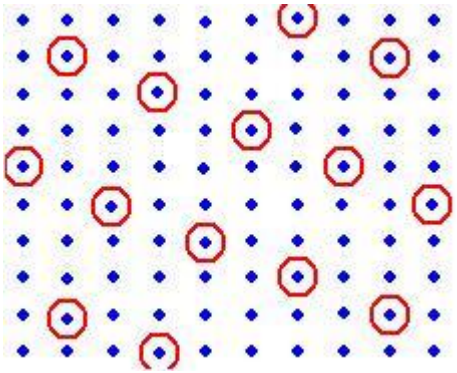
* Many farmed terrestrial animals are identified by an individual number
* Sampling frame in aquatic animals is different
* Random sampling can be applied using managment practices (during grading or transfer of fish, during vaccination, during harvest)
* Most frequently used method in farm is capture sampling
* Likely to introduce some bias into the sample and it is important to be aware of the direction of bias.

* Sampling method
  * Test entire population – census
  * Test sample (provide the greatest likelihood that the sample will be represenative of the population)
    * Representative from population
    * Non representative
* Large populations - sampling frame not available - multi-stage sampling

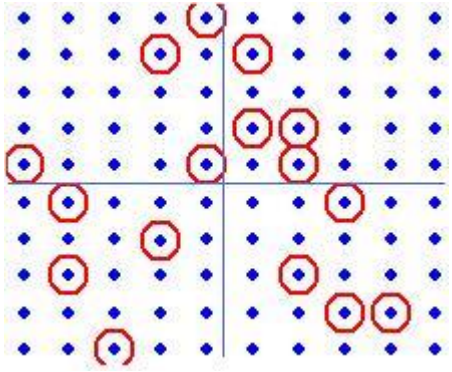
* Representative sampling – each individual in population has same and equal probability being selected into sample
  * Simple random sapling
  * Systemic random sampling
  * Stratified sampling
    * Proportionally stratified sampling
  * Cluster sampling



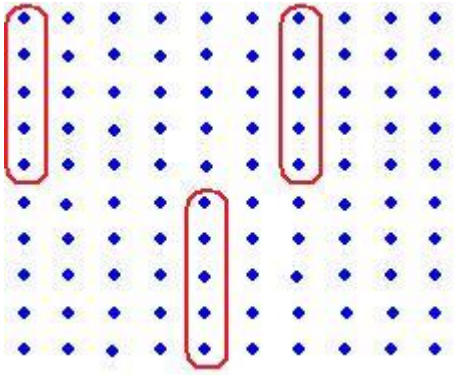
simple



systemic



stratified



cluster

* Random sampling requires **sampling frame (**all individuals/units accessible and identified)
* NOTHING IS RANDOM IN RANDOM SAMPLING!!!
* Alternative use systemic/spatial sampling
* It should be possible to use sampling frame in aquaculture population for epidemiological or higher unit (wilages/farms..)
* For individual aquatic animals – no sampling frame
* Use any method to achieve random selection – documented and described
* Convenience sampling never acceptable

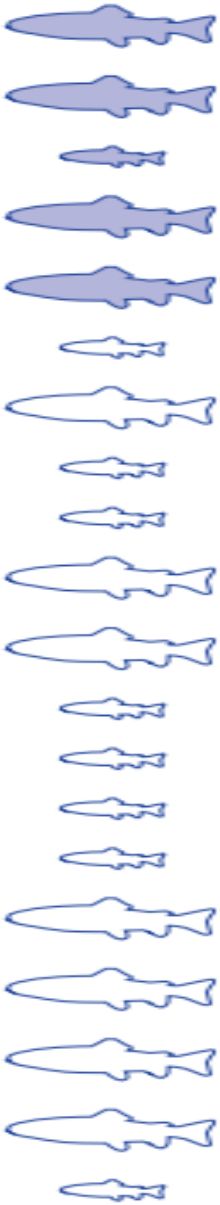
* Non representative sampling
  * Judgment sampling
  * Sampling of available animals – convenience sampling
  * Targeted sampling
  * Moribund /with lesions animals

Common non random surveillance data sources

* Disease reporting or notification system (i.e.early detection system)
* Control programs
* Targeted sampling
* Post - harvest inspection (biases in relation to target population and study population)
* Laboratory investigation records
* Biological specimen banks
* Sentinel units
* Field observations
* Farm production records

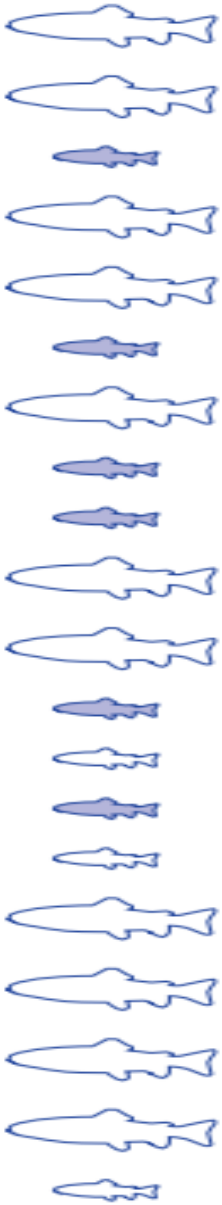
Examples of non-probability sampling

Convenience



First five fish selected

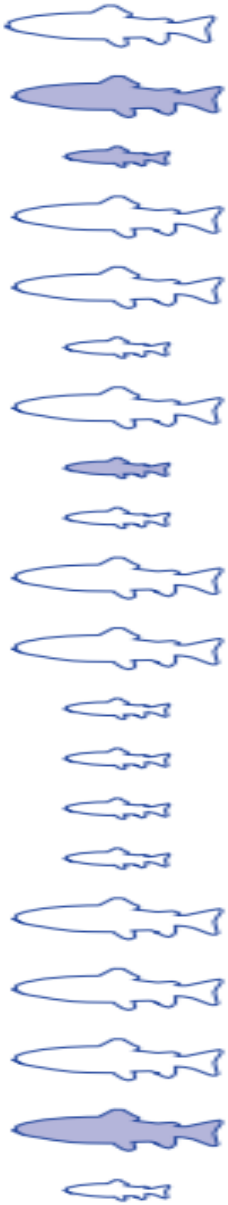
Purposive



Small fish selected for ease

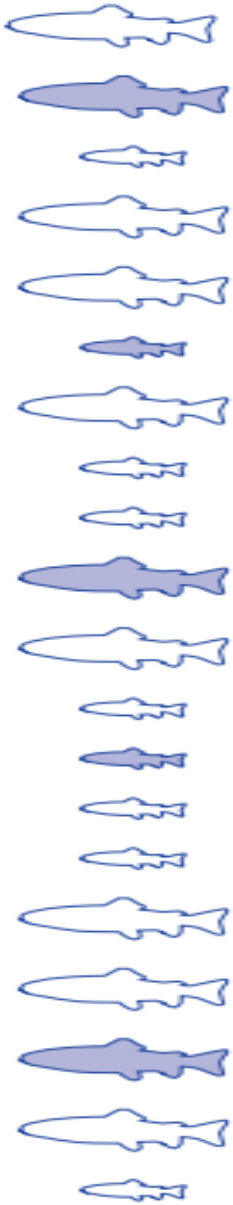
Examples of probability sampling

Random



Random numbers used to select fish

Systematic



Second fish selected with random number, then every fourth fish selected

Sample size

* The number of units to be sampled from a population should be calculated using a statistically valid technique, considering factors into account:
  * Purpose of survey
  * Imperfection of diagnostic test/s (Se, Sp)
  * the design *prevalence/s*
  * the level of confidence
* Other factors:
  * Population size (acceptable to assume infinitely large population)
  * The desired power of the survey
* Before – standardized tables
* Now – tailored calculation based on above factors

Sample size

* Sample size calculation should take into account diagnostic test performance
* However, for many diseases such data are not available and the assumption of perfect test is often used in the sample size calculation
* Sample size is dependent on:
  * Statistical consideration (desired precision, expected disease frequency)
  * Non-statistical consideration (resources, cost and sample availabilty)

AusVet
Animal Health Services

Software

- FreeCalc Version 2
- Survey Toolbox
- QCEL

Links to other epidemiological software can be found on the Useful Links page.

FreeCalc

FreeCalc is an epidemiological probability calculator designed to assist with the planning and analysis of surveys to demonstrate freedom from disease, or surveys to detect disease. FreeCalc has two modules, Sample Size calculation and Analysis of Results. Commonly used approaches to demonstrating freedom from disease have either

- failed to take into account the imperfect nature of laboratory tests (sensitivity and specificity not equal to 1), or
- assumed infinite population sizes (or sampling with replacement).

At the heart of FreeCalc is a new probability formula which adjusts for imperfect tests, and for population size, providing an exact result.

Sample Size

This module accepts as input

- Test sensitivity and specificity
- Population size

Epi Info™

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What is Epi Info™?

Physicians, nurses, epidemiologists, and other public health workers lacking a background in information technology often have a need for simple tools that allow the rapid creation of data collection instruments and data analysis, visualization, and reporting using epidemiologic methods. Epi Info™, a suite of lightweight software tools, delivers core ad-hoc epidemiologic functionality without the complexity or expense of large, enterprise applications.

Epi Info™ is easily used in places with limited network connectivity or limited resources for commercial software and professional IT support. Epi Info™ is flexible, scalable, and free while enabling data collection, advanced statistical analyses, and geographic information system (GIS) mapping capability.

Since its initial release, Epi Info™ users have self-registered in over 181 countries covering all continents including Antarctica. Epi Info™ has been translated in more than 13 languages.

More than one million users are estimated.

EDUCATION
Epi Info™ is a key component in public health education at colleges, universities, and other schools of public health around the world.

How is Epi Info™ Used?

Epi Info™ is used worldwide for the rapid assessment of disease outbreaks; for the development of small to mid-sized disease surveillance systems; as ad hoc components integrated with other large scale or enterprise-wide public health information systems; and in the continuous education of public health professionals learning the science of epidemiology, tools, and techniques.

EpiTools epidemiological calculators

This site has been developed by AusVet Animal Health Services, with funding from the Australian Biosecurity Cooperative Research Centre. 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.

Surveillance utilities

- 1-Stage representative freedom surveys New menu
- 2-Stage representative freedom surveys New menu
- Risk-based freedom surveys New menu
- Random Sampling from a population New menu
- Estimating true prevalence
- Pooled prevalence calculator
- Survey Toolbox for livestock diseases and freedom in finite populations
- HerdPlus module for herd-sensitivity and freedom in finite populations

Epidemiological studies

- Sample size calculations
- Summarise categorical or continuous data
- Statistical significance testing
- Probability distributions
- Bioequivalence analysis

Diagnostic tests

- Application of diagnostic tests

Suggested citation: Sergeant, ESG, 2015. Epitools epidemiological calculators. AusVet Animal Health Services and Australian Biosecurity Cooperative Research Centre for Emerging Infectious Disease. Available at: http://epitools.ausvet.com.au.

If you cite Epitools in your publications, please email the details or a copy of your paper to Evan Sergeant for inclusion in the reference list.

Sample size to estimate a proportion with specified precision

Input Values

This utility calculates the sample size required to estimate a proportion (prevalence) with a specified level of confidence and precision.

Estimated true proportion : 0.1

Confidence level : 0.95

Desired precision (+/-) : 0.05

Population size (for finite populations) : 1000

Submit

Inputs are the assumed true value for the proportion, the desired level of confidence, the desired precision of the estimate and the size of the population for limited population sizes. The desired precision of the estimate (also sometimes called the allowable or acceptable error in the estimate) is half the width of the desired confidence interval. For example if you would like the confidence interval width to be about 0.1 (10%) you would enter a precision of +/- 0.05 (5%).

The program outputs the sample sizes required to estimate the true value with the desired precision and confidence, for both an infinite population and for a population of the specified size. If population size is left blank or zero, only the sample size for an infinite population is calculated.

Sample size is calculated using the formula:

$$n = (Z^2 \times P(1 - P))/e^2$$

where Z = value from standard normal distribution corresponding to desired confidence level (Z=1.96 for 95% CI)
P is expected true proportion
e is desired precision (half desired CI width).
For small populations n can be adjusted so that n(adj) = (Nxn)/(N+n)

Sample size to estimate a single proportion

Analysed: Tue Aug 25, 2015 @ 22:03

Inputs

Estimated Proportion	0.1
Confidence level	0.95
Desired precision of estimate	0.05
Population size	1000

Results

	Sample size
Infinite population	139
Population = 1000	123

Table 2 Examples of sample sizes generated by FreeCalc for various combinations of design prevalence, test sensitivity and specificity values

Design prevalence	Sensitivity (%)	Specificity (%)	Sample size	Maximum number of false positives if the population is free
2	100	100	149	0
2	100	99	524	9
2	100	95	1,671	98
2	99	100	150	0
2	99	99	528	9
2	99	95	1,707	100
2	95	100	157	0
2	95	99	542	9
2	95	95	1,854	108
2	90	100	165	0
2	90	99	607	10
2	90	95	2,059	119
2	80	100	186	0
2	80	99	750	12
2	80	95	2,599	148
5	100	100	59	0
5	100	99	128	3
5	100	95	330	23
5	99	100	59	0
5	99	99	129	3
5	99	95	331	23

Test characteristic

* Surveillance involves performing one or more tests, ranging from detailed laboratory examination to observations by farmers.
* Performance of test at the population level is described in terms of its sensitivity and specificity
* Screening and diagnostic
* Gold Standard

Diagnostic test sensitivity of test applied for surveillance

* Lethal sampling is commonly used for rutine diagnostic (direct detection of pathogen)
* Different development of diagnostic test for AAD related with economic value of individual animals
* Diagnostic test Sn of many dg test for the notifible AAD is unknown
* Sn of screening test for pathogens can be further reduced by pooling samples
* Data on pathogen quantities shed by infected fish into the water are very limited

	1	2	3	4	5	6	7	8	9	10
1										
2										
3										
4										
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10										

* **No perfect test!!!**
* How much the test can be wrong
  * Overall
  * Diagnosing disease
  * Diagnosing health
* Imperfection of test/s for interpretation of surveillance data

	1	2	3	4	5	6	7	8	9	10
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2										
3										
4										
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6										
7										
8										
9										
10										

	testresult positive	testresult negative
true status positive	A	B (missed)
true status negative	C (false alarm)	D

Planning AAD surveillance

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3										
4										
5										
6										
7										
8										
9										
10										

	D	noD	
T+	45	3	48
T-	5	47	52
	50	50	100

	D	noD	
T+	45	3	48
T-	5	47	52
	50	50	100

True Prevalence = 50/100
Apparent Prevalence = 48/100

Ability of test to diagnose disease
Test sensitivity=45/50

Ability of test to diagnose health
Test specificity=47/50

$$TP = \frac{AP + SP - 1}{SE + SP - 1}$$

* Se/Sp must be known for test used to demonstrate freedom
* However, many test without data
* Options available:
  * To provide study on test before surveilance for national freedom
  * To use data from existing study in other populations
  * Expert opinion

* Any test can be used, as long as figures for Sn and Sp can be provided
* Clinical observations may be interpreted as test for the presence of disease.
* The sensitivity may be very low (more F-), and specificity moderately high (less F+).

* Combination of tests increases specificity on the expense of sensitivity and visa verse
* Independency of test results – use biologically independent tests
* For pooled sample testing use relevant Se/Sp

Review of available approaches/methodologies of surveillance

* Passive disease reporting
* Structured surveys - population based surveillance
* Sentinel surveillance
* Risk based surveillance
* Syndromic surveillance
* Participatory disease surveillance

Sentinel surveillance

* Alternative for population based surveillance
* Selected individuals/establishments
  * Fewer resources - restricted number of samples
* Regular complete reports
* One or more diseases
* NONREPRESENTATIVE for entire population
* Suitable for high risk groups – exotic diseases, rare diseases

Risk based surveillance for AAD

* The new EU legislation (CD 2006/88/EC) requires that surveillance to maintain the disease status is risk based
* Suggested method by different authors for ranking fish farms for pathogen introduction and spread

* Risk base surveillance
* Theory – EASY!
  * Looks where you expect disease to occur
  * More sensitivity with less samples
  * Efficient but cheaper
* Practice – LITTLE COMPLICATED!?
  * What is risk?
  * Where does it apply?
  * How to calculate sample size?

Oidtmann (2011): risk categorisation of farms

* Live fish and egg movements
* Exposure/spread via water
* Processing plant on site
* Geographical factors (flood risk)
* Mechanical transmission

Score for risk of introduction and spread are calculated separatly and then combined to an overall score.

Risk based surveillance

* Relative risk
* High risk: 10% animals, 80% prevalence
* Low risk: 90% animals, 20% prevalence
* True prevalence 17%
* Apparent prevalence 80%

* Risk - likelihood of adverse event
* Likelihood and consequences – result of risk analysis
* Risk based surveillance
  * Risk factors (water temperature, age, moribund, ...)
  * Difference in risk (with and without risk factor) – relative risk
  * Sampling contribution of high risk subpopulation

* Relative Risk
  * Risk of event (disease) relative to exposure (risk factor)

	D	noD	
Exposed	10	40	50
Non exposed	5	45	50
	15	85	100

Sampling type	High risk population %	Low risk population %	Sample size	%saving
Representative	20	80	331	0
Risk based (RR=3)	50	50	231	30
Risk based (RR=3)	90	10	165	50
Biased (non representative)	10	90	387	-17

Prevalence 1%, Test sensitivity 90%

Syndromic surveillance

* Early detection of outbreaks
  * a threshold number of early symptomatic cases
* Well-defined disease or clinical syndromes
* Indicates unusual clustering or sentinel cases
* Trends – size, spread and tempo
* Use existing health data

Participatory surveillance

* Give stakeholders greater role
* overcomes limitations of conventional epidemiology
* developed in small-scale applied to major international disease control efforts – OIE – rinder pest
* Provides: observations, semi-quantitative scores, quantitative data

Before start to plan keep in mind special challenges of aquatic animals disease surveillance

* Patogen exposure and transmission
* Likelihood of disease expression: Interaction pathogen-host-environment
* Population
* Diagnostic test sensitivity of test applied for surveillance
* Design prevalence
* Sample size
* Random sampling

Patogen exposure and transmission

* The most important pathway is probably via introduction of infected (mostly subclinically) live fish directly onto farm
* Fish to fish transmission (population density on farm)
* True vertical transmission appears not to occur for most of notifiable fish diseases
* Biosecurity

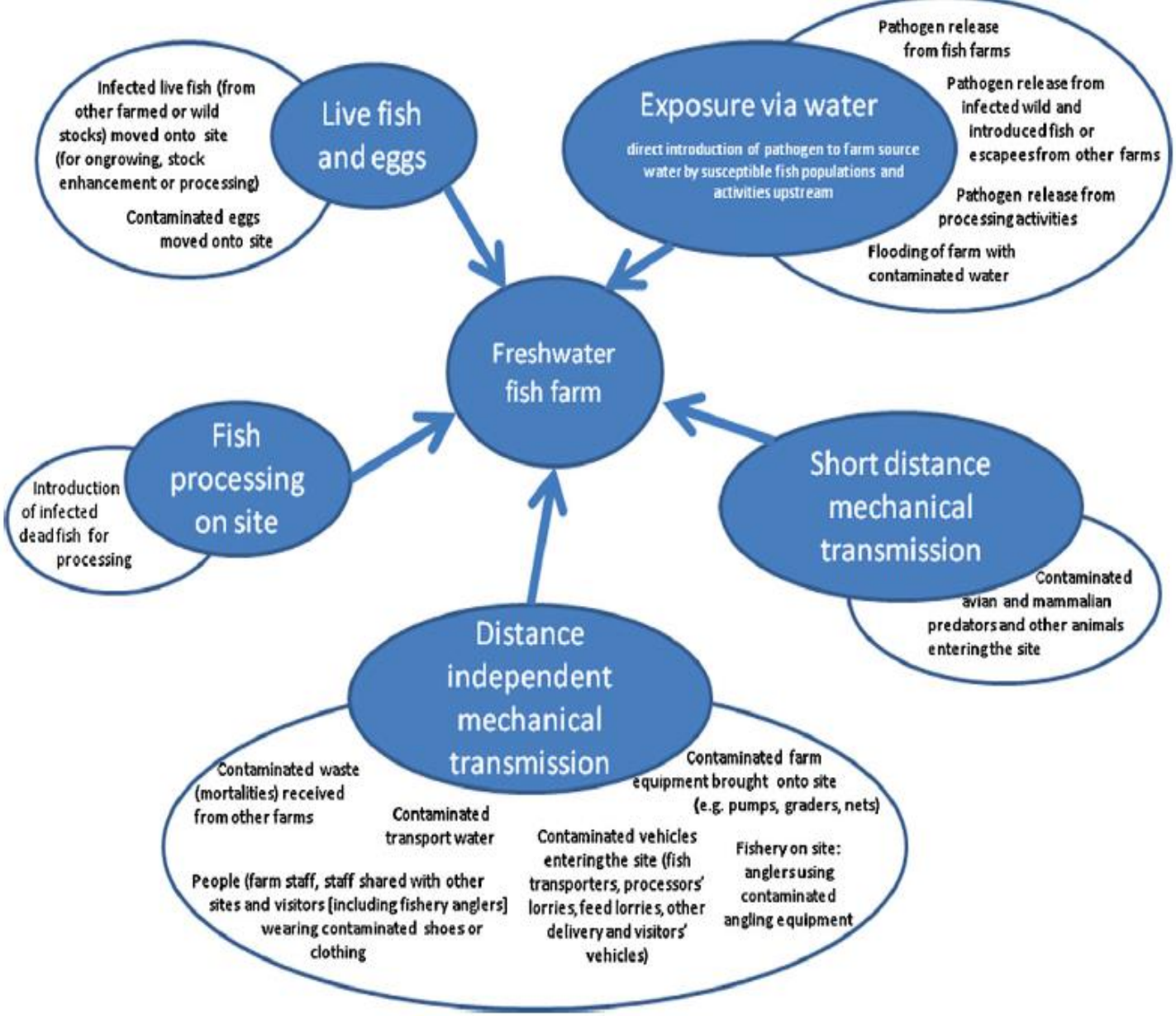
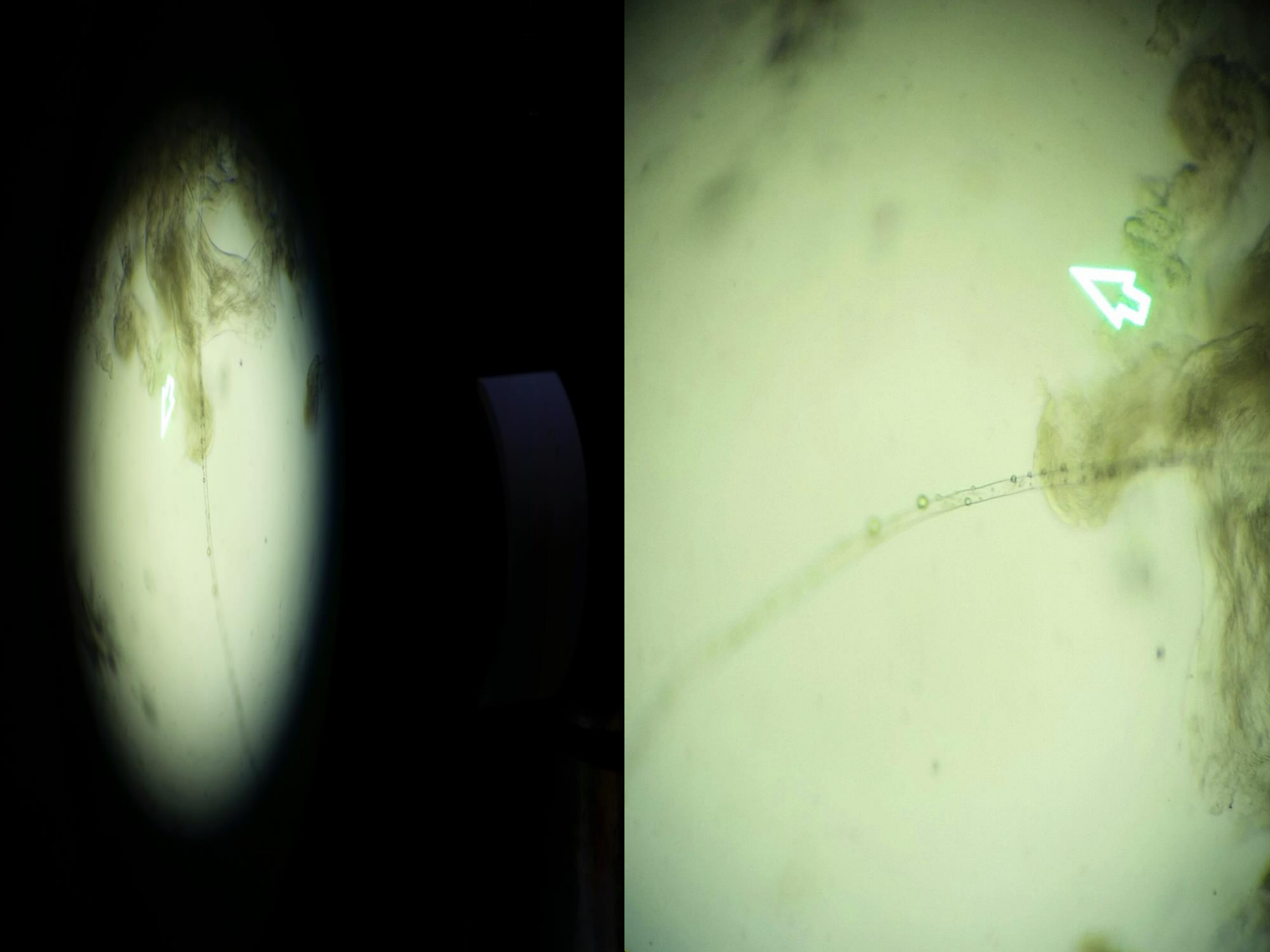


Fig. 1. Pathways of pathogen introduction to a freshwater fish farm. Freshwater fish farms may be exposed to multiple routes of pathogen introduction, which can be grouped into risk themes (risk themes shown as filled oval shapes surrounding the freshwater fish farm oval in the centre). Examples of pathways falling into each risk theme are listed in the white ovals attached to the respective risk theme oval. More detail on each risk theme is provided in the text.

Likelihood of disease expression: Interaction pathogen-host-environment

* Aquatic animals are ectothermic (body temperature is largely the same as the ambient water temperature)
* Immune system varies with water temperature
* Pathogen survival and amplification is temperature dependent
* Overall, tempeature is probably the most relevant environmental factor in the pathogen-host-environment triad.



Before start of planning

* Are we doing the **right thing**?
  * Are the results we see due to the programme/intervention/policy?
  * What would have happened in the absence of the programme?
* Are we **doing it right**?
  * Can we do things more effectively and/or efficiently?
  * Can we gain more for the resources we invest?

And more..

* Surveillance is an economic activity
  * Which surveillance?
  * How much surveillance?
* Surveillance is an economic activity
  * What is the value of information?
  * Who should pay for what?

Planning AAD surveillance

* Current status of disease
* Objective of surveillance
* Data type and sources
* Population, coverage, representativeness
* Approach/methodology

Example 1: Farm accreditation (one stage structured survey)

- Objective: surveillance to prove that individual farm is free from TiLV (**disease freedom**)
- Survey standards:
  - 95 % confidence that disease will be detected if present
  - The power of survey at 95 % (type II error meaning there is a 5 % chance of concluding that farm without infected animal is infected)
- Once farms have been surveyed without detecting disease they are recognised as free, as long as they maintain a set of minimum biosecurity standards

* Target population all fish on farm (i.e. 4 thanks, total 15,250 fish)
* DP 2 %
* Diagnostic test:
  * Gross pathology
  * Histopathology
  * Elisa
  * Sn? Sp?
* Sample size: 169 fish

Sampling

* 4 thanks:1,850; 4,250; 4,270; 4,880)
* Total: 15,250 fish
* Simple random sampling
* Proportional stratified sampling will guarantee that each thank is represented
* First thank 1850/15,250 = 12,13 % (21 fish)
* How to select fish from thank?
  * During harvest or or routine management (systematic sampling: 21 from 1850 means interval of 88
  * Capturing (dip net at different locations)

Analysis

* If the calculated sample of 169 is used, and **no positive** reactors are found, the the survey will have a confidence of 95%.

Example 2: National freedom (two stages structured survey)

- Objective: surveillance to prove that country is free from TiLV (**disease freedom**)
- Approach:
  - Sampling villages at the first level, and ponds at second
  - The unit of observation and analysis is pond (infected or not infected pond)
- Survey standards:
  - 95 % confidence that disease will be detected if present
  - The power of survey at 95 % (type II error meaning there is a 5 % chance of concluding that farm without infected animal is infected)
- Once farms have been surveyed without detecting disease they are recognised as free, as long as they maintain a set of minimum biosecurity standards

Tests

* Farmers observations (quite sensitive, not very specific)
* PCR
* Culture

DP

* Should be calculated at two levels
* Pond level design prevalence(5%)
* Village level (1%)

Example 3: Spatial sampling