Surveillance for pathogens demonstrated absent – when can we stop?

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Photo: C. Zepeda
List of pathogens - and diagnostics – is extensive and rising

**OIE List for Finfish**

- Epizootic haematopoietic necrosis
- Epizootic ulcerative syndrome
- *Gyrodactylus salaris*
- HPR-deleted or HPRO infectious salmon anaemia virus
- Salmonid alphavirus
- Infectious haematopoietic necrosis
- Koi herpesvirus disease
- Red sea bream iridoviral disease
- Spring viraemia of carp
- Viral haemorrhagic septicemia

**Other Finfish Diseases of Concern**

- Bacterial kidney disease
- Infectious pancreatic necrosis
- *Piscine reovirus*
- Totivirus

Some diagnostics cover multiple pathogens (e.g., cell culture), but with varying sensitivity

Photo: ISA Program Maine
List of pathogens - and diagnostics – is extensive and rising

### OIE List for Molluscs

- Abalone herpesvirus
- Bonamia exitiosa
- Bonamia ostreae
- Marteilia refringens
- Perkinsus marinus
- Perkinsus olseni
- Xenohaliotis californiensis

### Other Mollusc Diseases of Concern

- Haplosporidium nelsoni
- Marteiliodes chungmuensis
- Mikrocytos mackini
- OsHV-1 μvar
- Vibrio tapetis

Bonamia ostreae, photo by Elston, R.
We’re good at the ‘opening’; need to be just as good at the ‘close’ for surveillance

Photo: ISA Program Maine
Not an easy task:
Sampling is a snapshot - a space/time slice - of a complex and dynamic system

Long-term accuracy depends not just on sample size, but on stability and homogeneity of the system
OIE provides guidelines: stopping rules (‘maintaining freedom status’) for highly clinical pathogens

- **Stop after demonstration**
  - e.g., 2 years of negative test results
  - IF conditions are conducive to clinical expression, and
  - IF early detection systems are in place

- **OIE Code examples for country/zone/compartment**
  - VHSV, IHNV
  - *B. existiosa, B. ostreae, Perkinsus marinus*

Photo: A. Noyes, VHSV outbreak gizzard shad
OIE guidelines: stopping rules (‘maintaining freedom status’) for non-clinical pathogens or conditions

• Continue ‘commensurate with risk’ (‘according to likelihood of infection’)
  • Still presuming early detection systems are in place

• OIE Code examples:
  • ISAV-free country/zone/compartment
  • Most pathogens, if local conditions are not conducive to clinical expression
On paper, this is sensible: In practice, there are nagging concerns

• Is 2, 3, 5 years long enough?
• How do we know a farmer will report clinical conditions?
• Observational surveillance won’t detect non-clinical.
• What is ‘commensurate with risk’?
A common default: Treadmill testing

Rationale: Traditional model forms basis for trade
Result: Resource exhaustion and limited reserves for emerging issues
Solution: Refresh (review, renew, respite)
Where’d they put the pause button?!

- Our instruction manual should include
  - Further guidance on methods to retire or reduce surveillance
  - Some example applications – ideally for facilities, compartments and zones
Case-studies may help motivate solutions

Closed, land-based, systems

Open, managed, systems

Hypothetical rainbow trout farm (akin to a compartment)

Hypothetical pacific oyster system (akin to a zone)
Closed systems *should* be easy

- Surveillance system components for our example farm
  - Active surveillance history, > 95% confidence
    - 2+ years for EHN, IHN, ISA, IPN, SAV, VHS
  - Early detection system in place
  - Negligible introduction risk per formal risk assessment

‘Commensurate with risk’ suggests it is safe to stop

But, we don’t …. 
What is the best duration for testing: Is 2 years enough?

A single year (multiple seasons) may be enough for most

We’ll likely detect if sampling occurs when disease is above the design prevalence (threshold).
What constitutes a strong ‘early detection system’?

• Here, this includes observational surveillance with triggers for veterinary investigation

• Concerns
  • Relies on farmer for clinical observations
  • Provides little assurance for non-clinical diseases
Routine moribund surveillance would address early detection concerns

• Periodic, high-value, sampling
  • Can incorporate veterinary visits
  • Can reduce sampling to very small number and retain assurance for most pathogens

60 fish or fewer may suffice
What about open systems?

Where introduction risks are non-negligible or unclear
Zone borders follow natural boundaries, not facility walls

Some immediate benefits:
• Commercial populations may serve as sentinels for wild, and vice versa
• Data responsibilities shared across stakeholders and sites
This calls for an approach ‘commensurate with risk’

What are the pathways for disease introduction *into the zone*?
How do we adjust surveillance to compensate for those risks?
Methods available, few described examples

- Risk assessments
- Scenario trees
- Expert panel models
Expert panel estimates disease introduction pathways and risks for mollusc zones

- Panel members
  - D. Bushek (Rutgers)
  - R. Carnegie (VIMS)
  - R. Elston (AquaTechnics)
  - C. Friedman (UW)
  - C. Giray (Kennebec River Biosciences)
  - T. Meyers (AK DFG)
  - R. Smolowitz (Roger Williams)
Perceived predictors of mollusc pathogen introduction (to a zone)

- Predictive factors
  - Proximity of pathogen threat
  - Level of commercial activity related to aquaculture, stock enhancement or ornamental trade
  - Degree of import control for mollusc cultivation
  - Degree of import control for ornamental trade
  - Changes to marine fauna or environment
  - Active ports for commercial vessel traffic
  - Processing plants or restaurants sourcing from other regions

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<td>0.6</td>
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‘commensurate with risk’
Use this measure of introduction risk to revise surveillance needs

• Bayes’ theorem allows us to calculate the value of prior data
  • And off-set current sampling requirements (commensurate with risk)

• PosteriorOdds = PriorOdds \cdot LR_{(RF1)} \cdot LR_{(RF2)} \cdots \cdot LR_{(RFx)}
Surveillance system components for our ‘zone’

• Complete initial surveillance
  • Twice annual sampling
  • Histopathology
  • Limited sensitivity, broad reach
  • 95% confidence, multiple pathogens
  • Is two years enough?

• Assess introduction risks
  • Determine IR score by pathogen
  • Continue monitoring pathways

• Adjust ongoing sampling
  ‘commensurate with risk’
Examples and guidelines on the resolution of surveillance will ease implementation

Key benefits:
• Allocate resources according to information needs
• Improve decision support
• System refresh

Key questions:
• What is sufficiency of early detection?
• What is ‘commensurate with risk’?
• How long is long enough?
• How can we best use recovered funds?
Thanks!