World Organisation for Animal Health

SEACFMD

SEACFMD EPIDEMIOLOGY NETWORK MEETING

Outbreak Investigation

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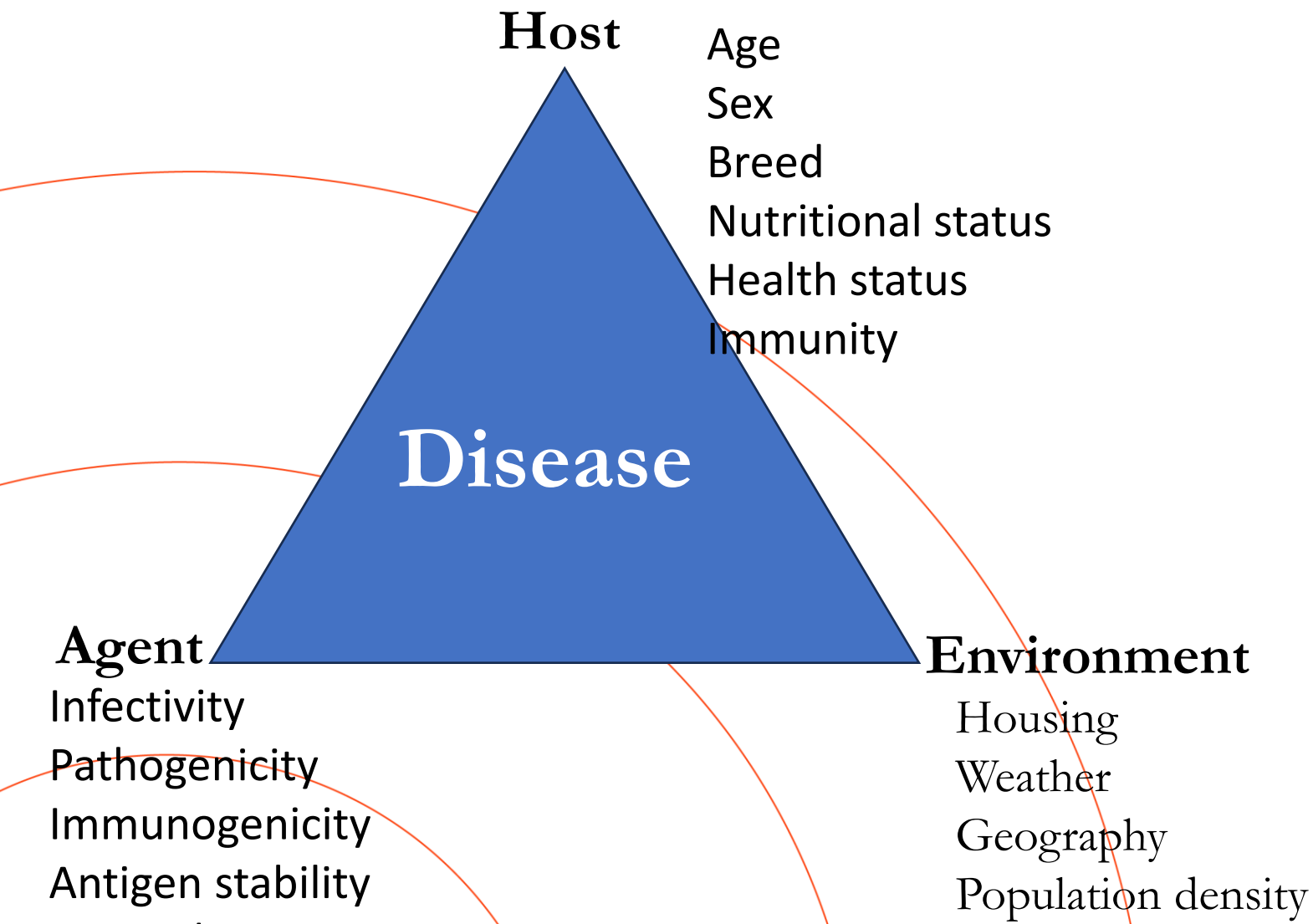
Outline of the Presentation

- Why disease outbreak occur?
- Why investigate an outbreak?
- Key steps in outbreak investigation
  - Verify
  - Investigate
  - Develop and test hypothesis
- Implement Interventions
- Communication Findings

Why disease outbreak occur



Disease occurs

- Agent capable of causing disease (for example, a virus or bacteria)
- Host is vulnerable (susceptible) to the agent
- Environment that allows the agent and host to interact

Disease outbreak occurs

- When there is chain of transmission for the agent to pass from one host to another.

What is an Outbreak?

An outbreak is a *series of disease events clustered in time and space*.

An **outbreak** means the occurrence of one or more *cases* in an *epidemiological unit*.

Case means an individual animal infected by a pathogenic agent, with or without clinical signs.

Epidemiological Unit means a group of animals with the same likelihood of exposure to a pathogenic agent.

May involve a single herd, a district or an entire country

- Covid-19, Foot-and-mouth disease, African swine fever

We ask the questions:

- what is the problem?
- can something be done to control it?
- can future occurrences be prevented?

Why investigate an outbreak?

- To identify the source(s) of infection.
- To prevent further exposure of animals to the infection source(s).
- To determine where the disease has spread/stop spread.
- To guide control measures during and after the outbreak.
- To improve knowledge on the behaviour and pattern of disease.
- To improve knowledge of the risks and routes of introduction.

Key steps of an outbreak investigation

Questions: what, who, when+where, how much, where from/to ?

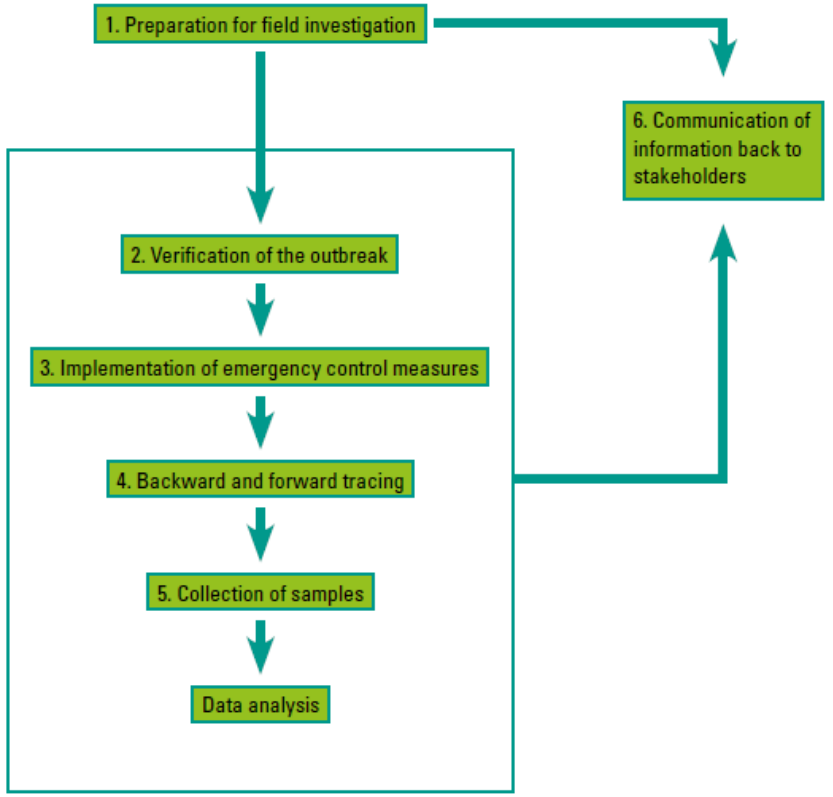
Step 1: Verify outbreak:

- What's the problem?/ true excess or chance variation?

Step 2: Investigate outbreak:

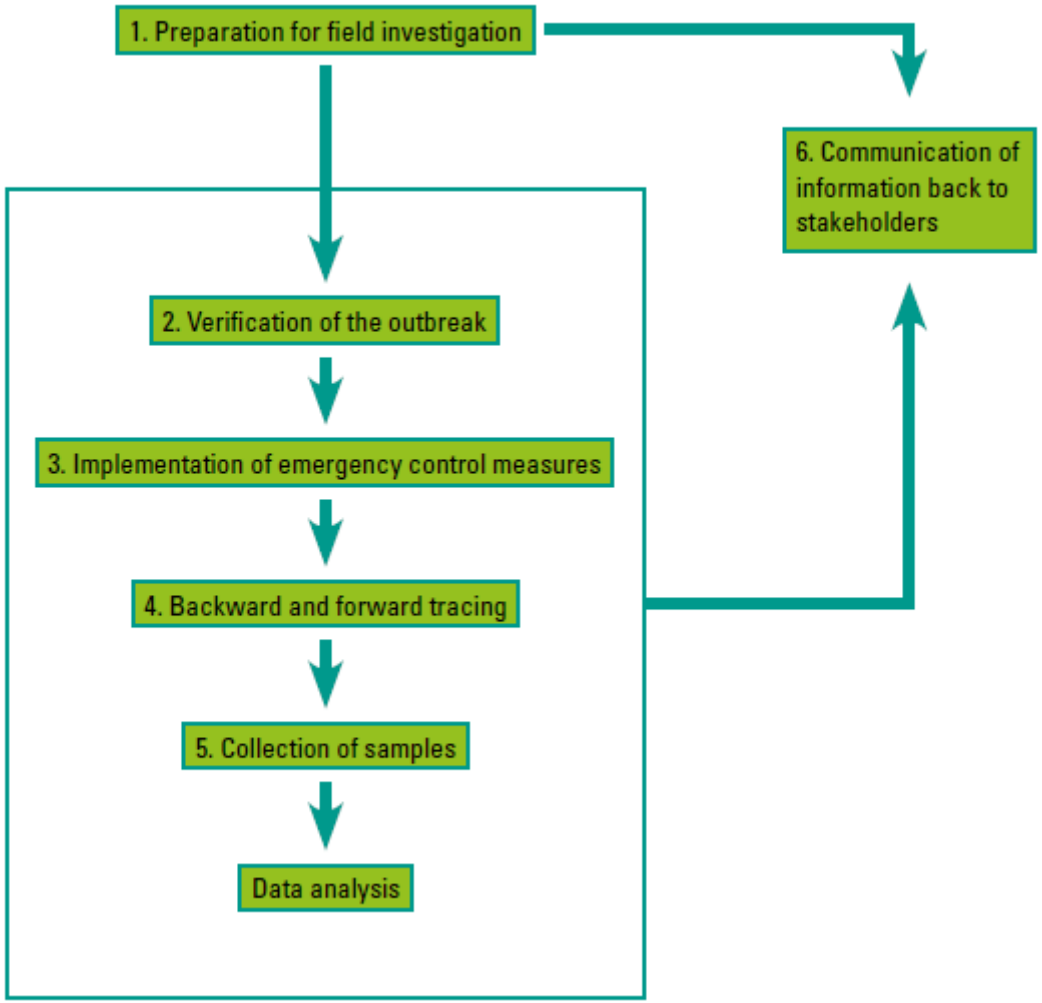
- Develop case definition for active case finding
- Describe case occurrence by individual/place/time
- Develop & Test hypotheses

Step 3: Implement interventions:



Steps by steps guide to outbreak investigation and management

1. Prepare for fieldwork
2. Establish outbreak existence
3. Verify the diagnosis
4. Define and identify cases
5. Describe and orient data in terms of time, place, and person
6. Develop hypotheses
7. Evaluate hypotheses epidemiologically
8. Refine hypotheses & carry out additional studies
9. Implement control and prevention measures
10. Communicate findings



Tools used for Outbreak investigations

- Supplies – PPE, data forms, sample collection equipment, transport)
- Statistical tools – Epidemic curves (Excel, other tools; GIS mapping
- Questionnaires, checklists
- Diagnostic kits, lab protocols
- Communication platforms

Verify the outbreak

Describe the illness or the problem:

- Characterise cases in the form of a working definition

For example "*Sudden death in grower pigs*"

or "*Salivation, foot and/or mouth lesions*"

- Throughout the investigation, this working definition will lead you to the case definition

Verify the outbreak

Is there a true excess (more than usual) of disease?

- Obtain objective data to document and verify the magnitude of the problem
- Don't rely on memories and perceptions of management and superiors

*BUT perceptions of employees, managers and practitioners are valuable sources of hypotheses about risk factors

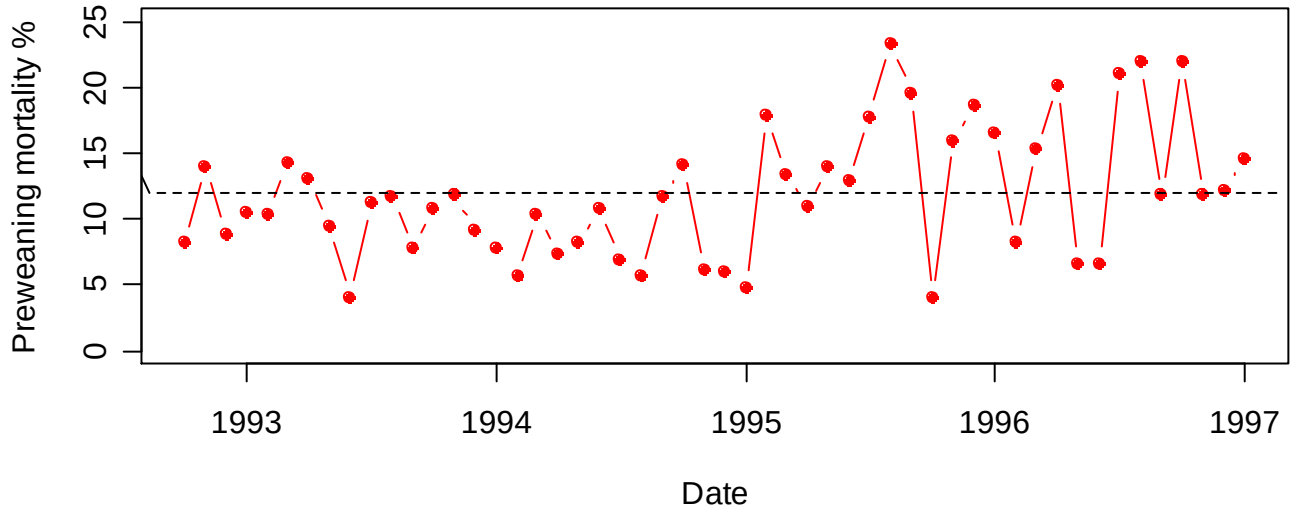
- Compare the actual number of cases to the expected number to determine whether or not the frequency is excessive
- ask what producers accept as normal (chronic problems lead to an increased tolerance of what is 'normal')

Consider to

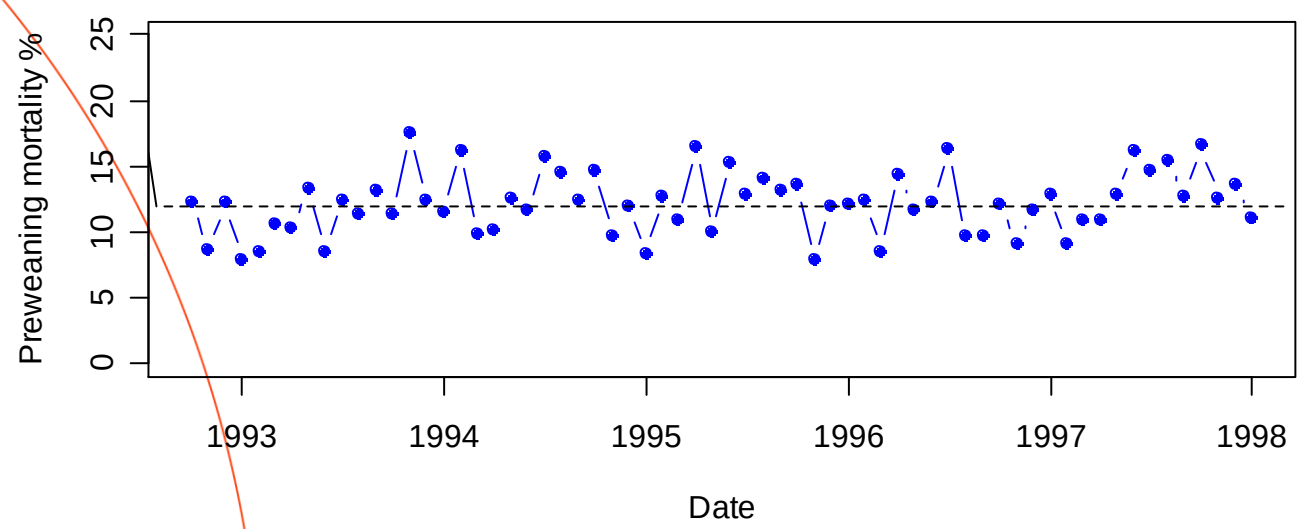
- account for the number of animals actually at risk at the time of the outbreak

Is there a true excess (more than usual) of disease?

- **OUTBREAK:** on this farm, preweaning mortality started to increase after 1995. Most subsequent monthly incidences were above the average



- **NO OUTBREAK:** for comparison, this farm shows consistent preweaning mortality over time without any strong and lasting increases



Investigate the outbreak

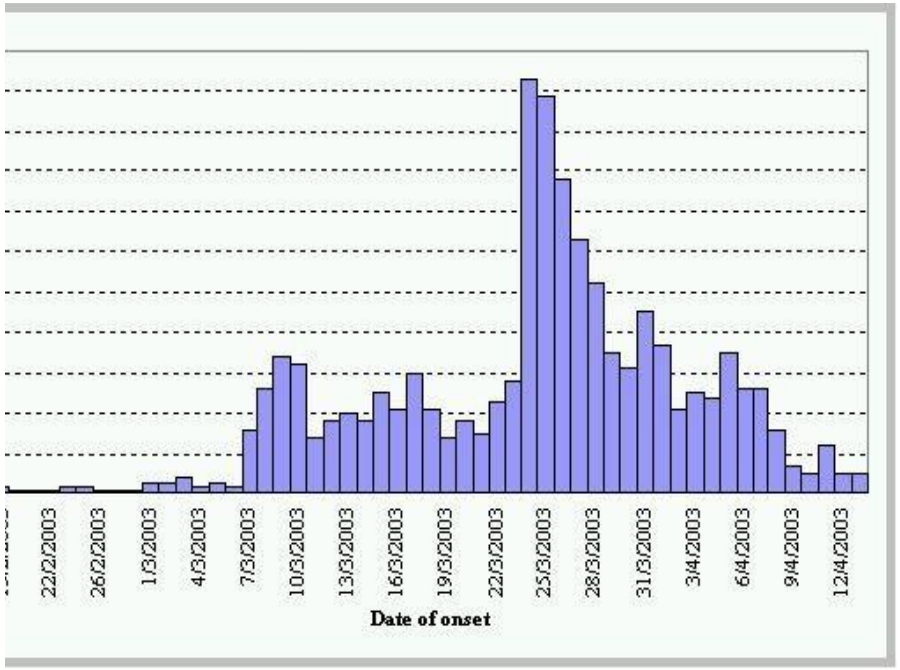
Establish a case definition for active case finding

- Systematically identify sick animals or herds: ex. '*more than 10% animals with FMD-like lesions in mouth and/or claws within one month*'
- If you can't make a definitive diagnosis, provide a probable case definition, ex. '*sudden death in recently weaned calves*'
- If you can make a definitive diagnosis by laboratory confirmation, then the case definition is easy (e.g. FMD in cattle)

Investigate the outbreak

Describe the occurrence of disease in terms of

- Individual
- Place
- Time



Investigate the outbreak

Describe the occurrence of disease in terms of the Individual

- Compare affected animals with unaffected individuals
- Attack rate = no. cases / total number present at the start

What are potential risk factors of affected and unaffected individuals?

- age/ breed/ sex/ species/ pregnancy status/ lactation stage
- vaccination status
- time spent at this place (new introduction? from where?)
- feed/grazing sources and supplements
- others

Investigate the outbreak

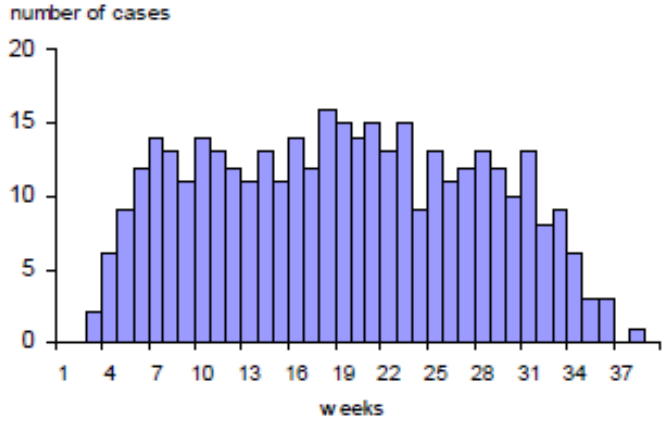
Describe risk factors of disease in terms of Place

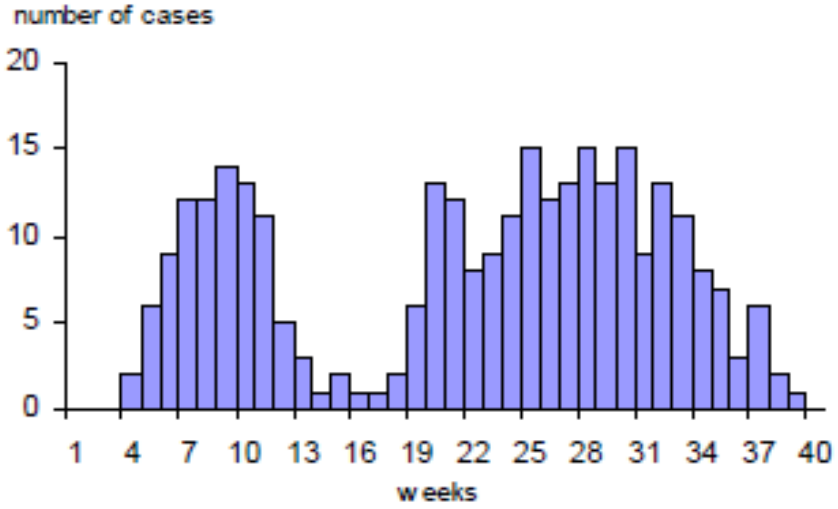
- Where are the affected and unaffected animals located?
- Cluster/aggregation of disease events in area

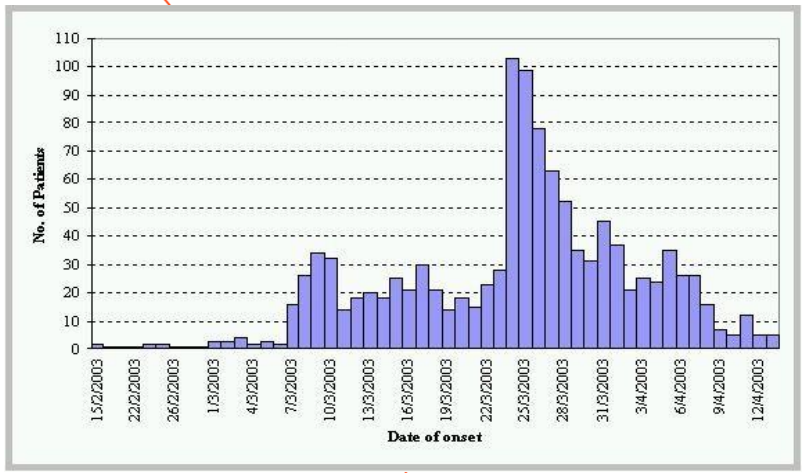
Investigate the outbreak

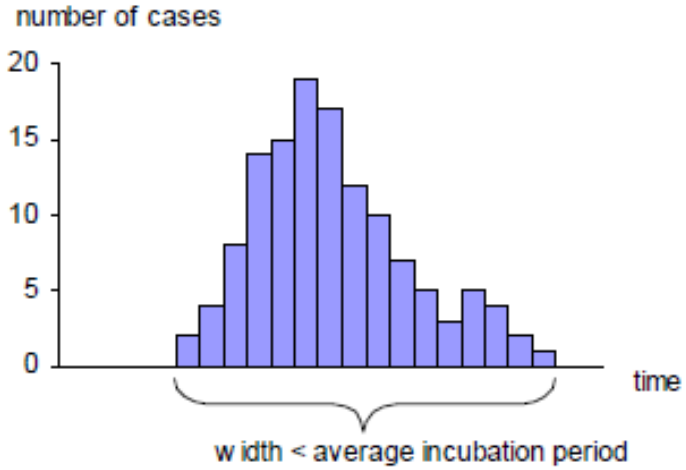
Describe the occurrence of disease in terms of Time

- Point source
- Intermittent common source
- Continuous common source
- Propagated epidemic





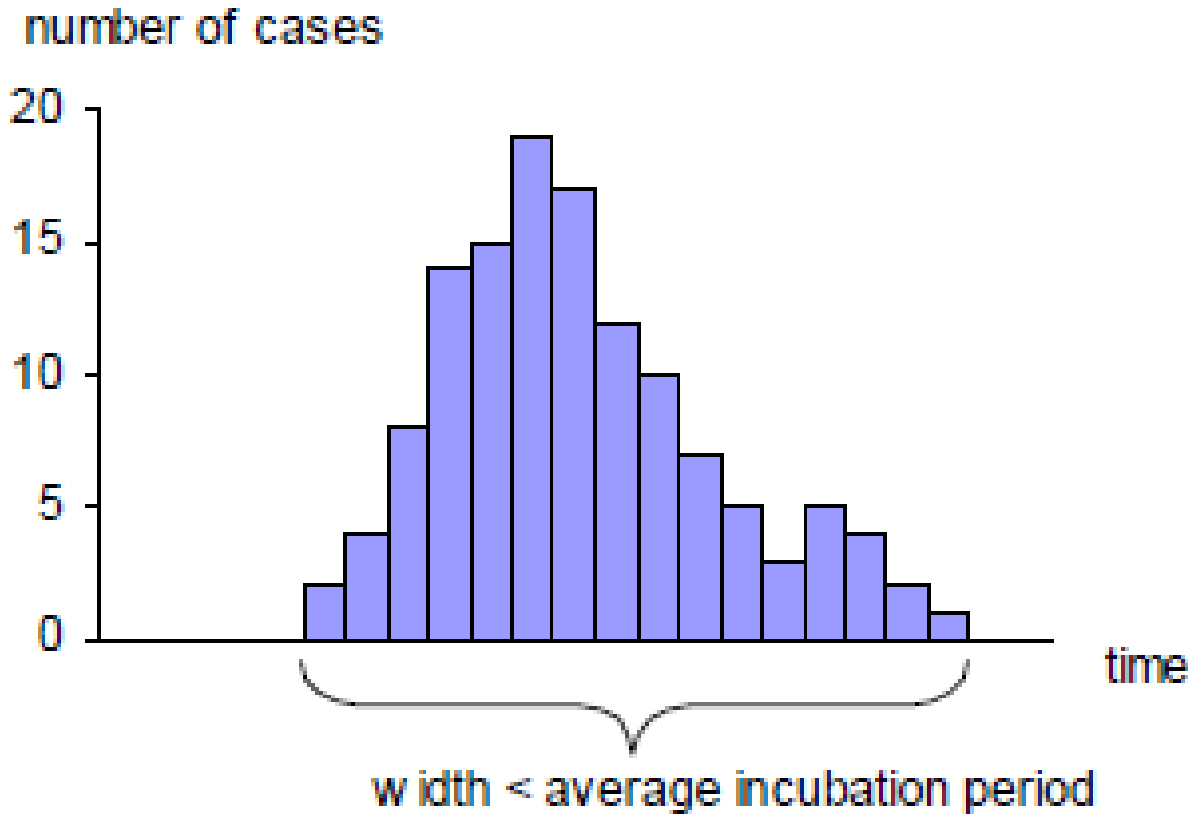




Investigate the outbreak

Point-source

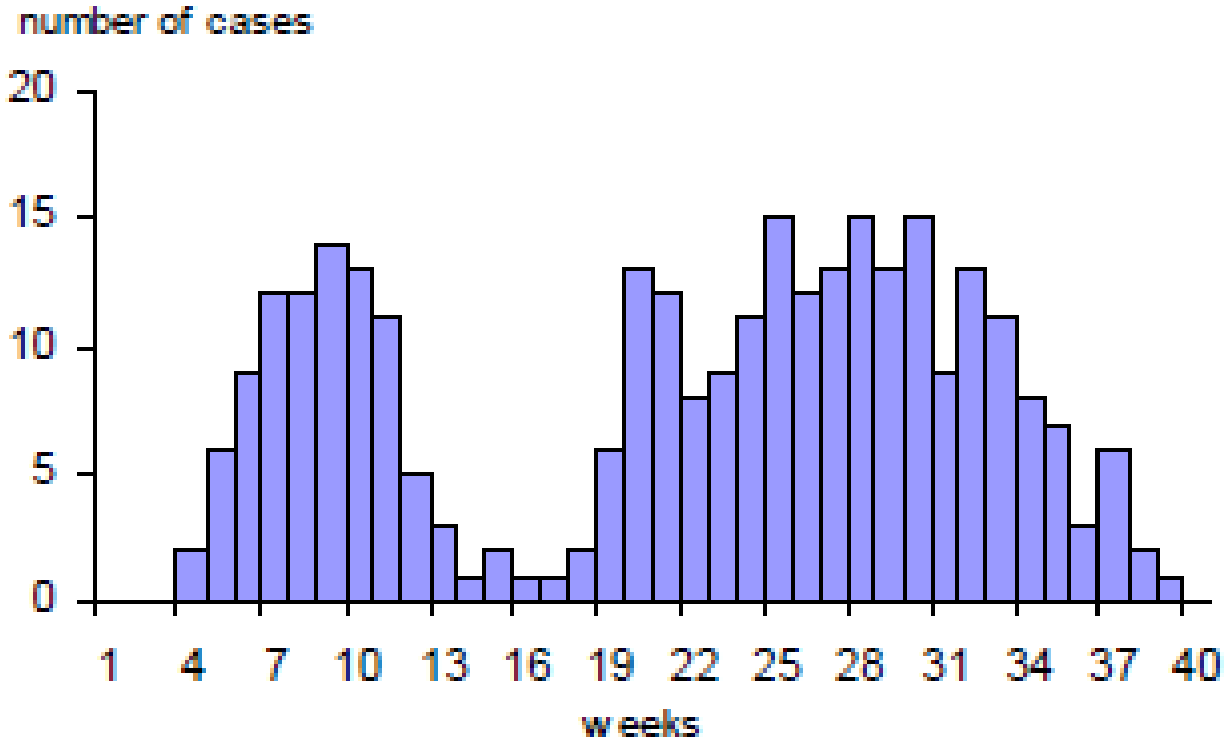
- Example: a cruise ship dinner where contaminated food was consumed



Investigate the outbreak

Intermittent common-source

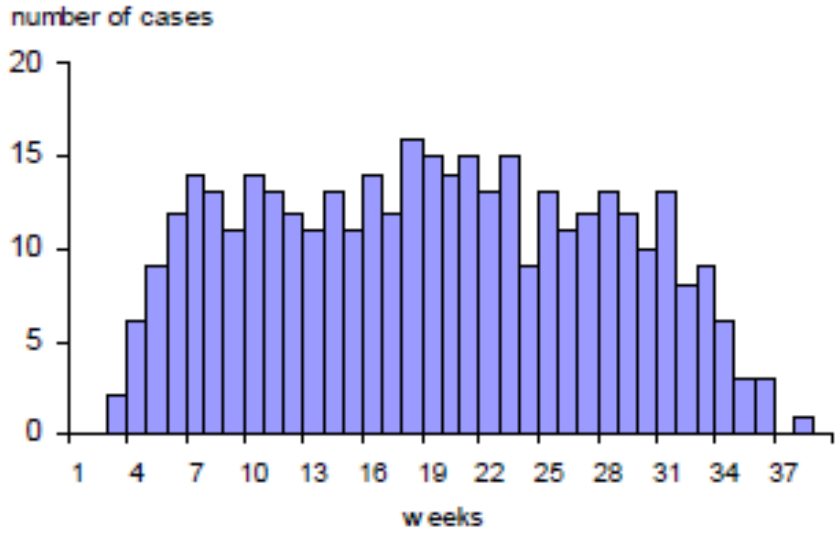
- For this type of epidemic, the risk factor is of a single source but exposure is not confined to one point in time.
- Example: Covid-19.

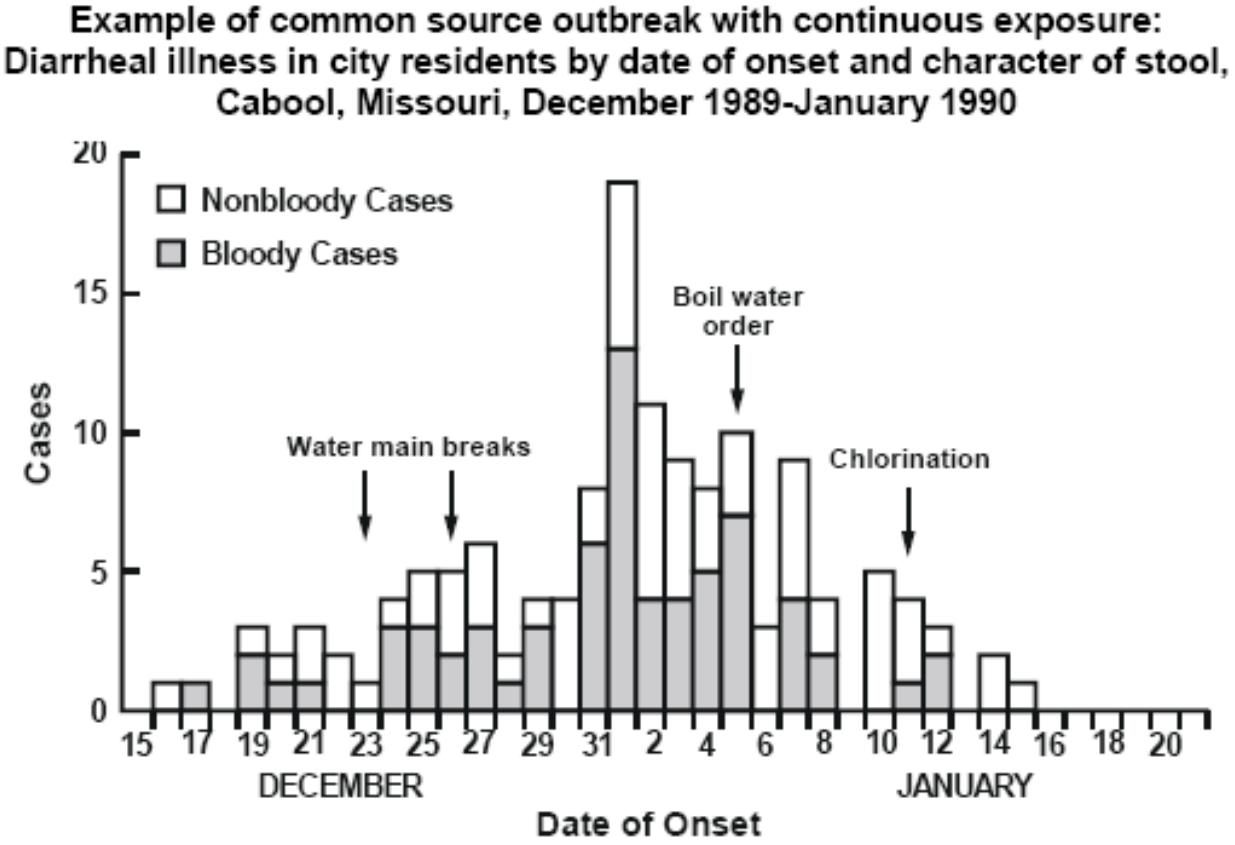


Investigate the outbreak

Continuous common-source

- The duration of the outbreak depends on how long the exposure persists.
- Example: infectious diarrhoea



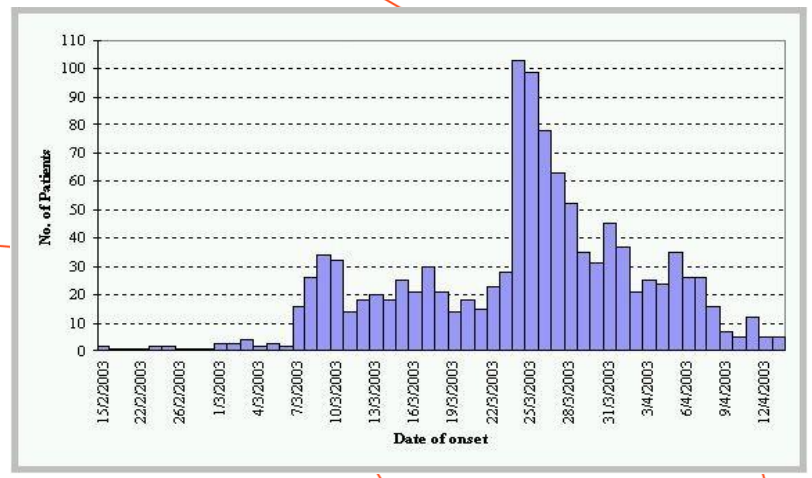


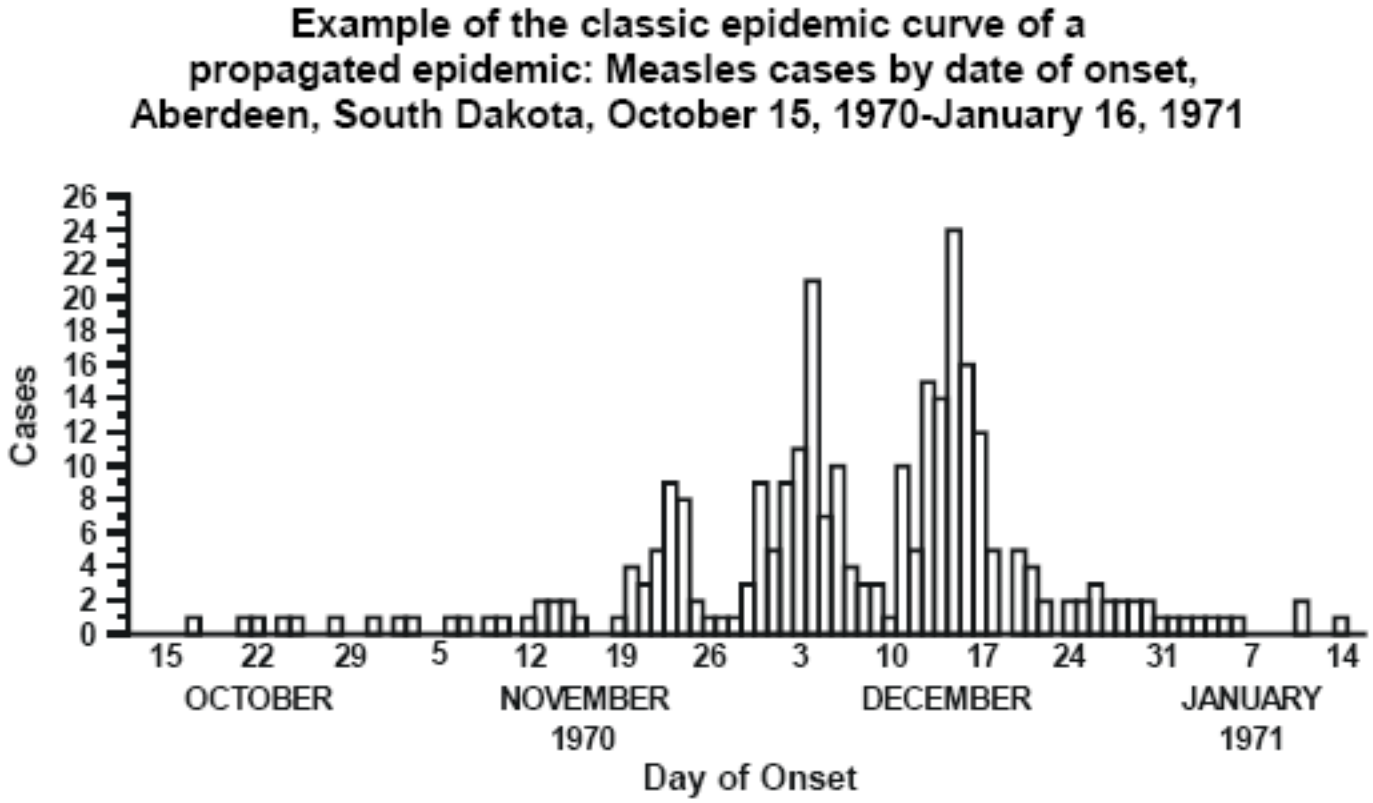
Source: CDC, unpublished data, 1990

Investigate the outbreak

Propagated

- The mode of transmission in this type of epidemic is usually from one subject to another through direct contact (typically infectious) or through an intermediate host.
- Example such as FMD





Investigate the outbreak

What an Epi Curve Can Tell You?

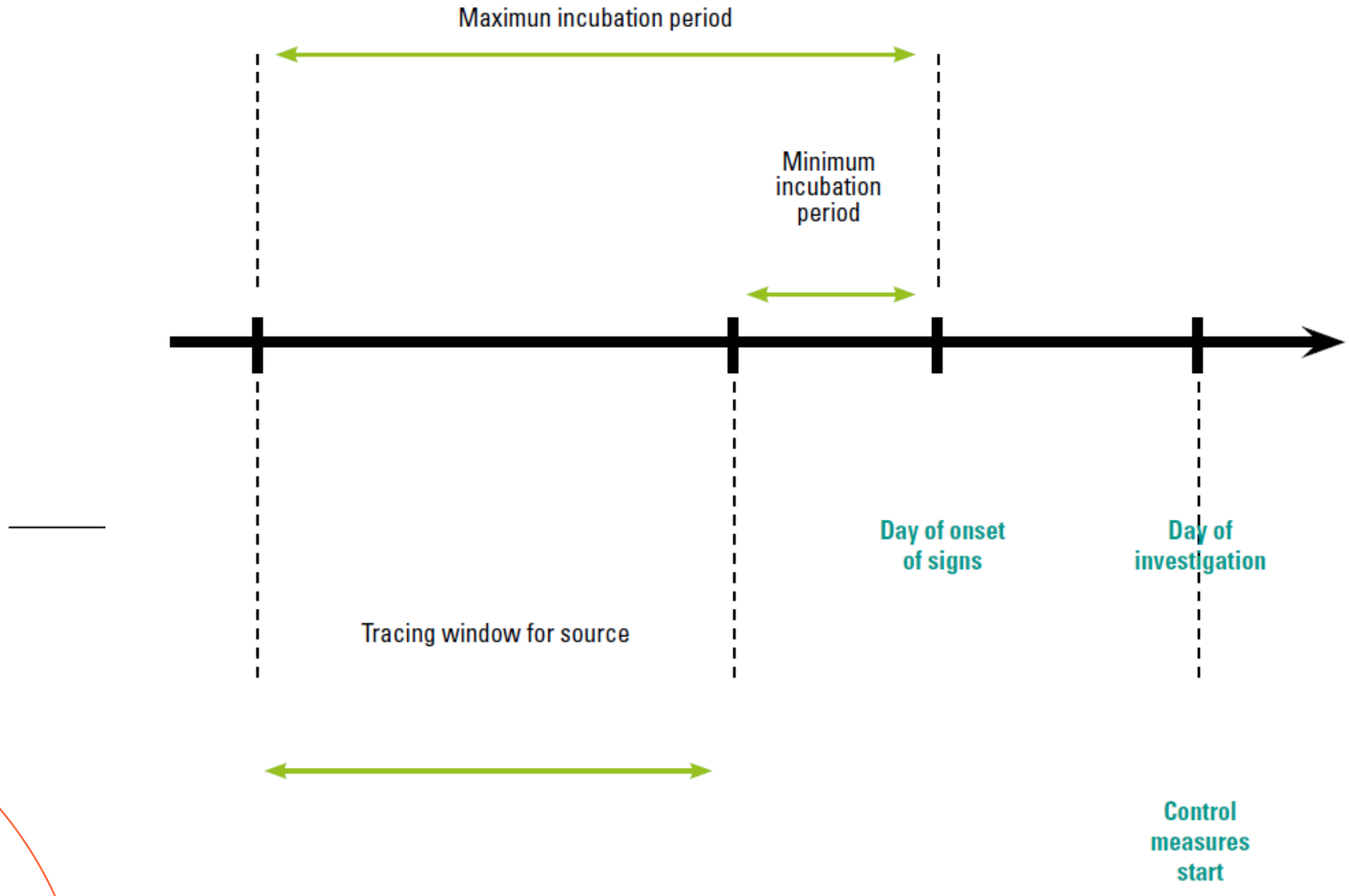
An epi curve is a visual display of the onset of illness among cases associated with an outbreak.

You can learn about an outbreak from epi curve, such as

- The distribution of cases over time and when the first case likely occurred.
- The most likely period of exposure
- General sense of the illness magnitude
- Outliers, that is, cases that stand apart from the overall pattern
- Tracing window for source and spread

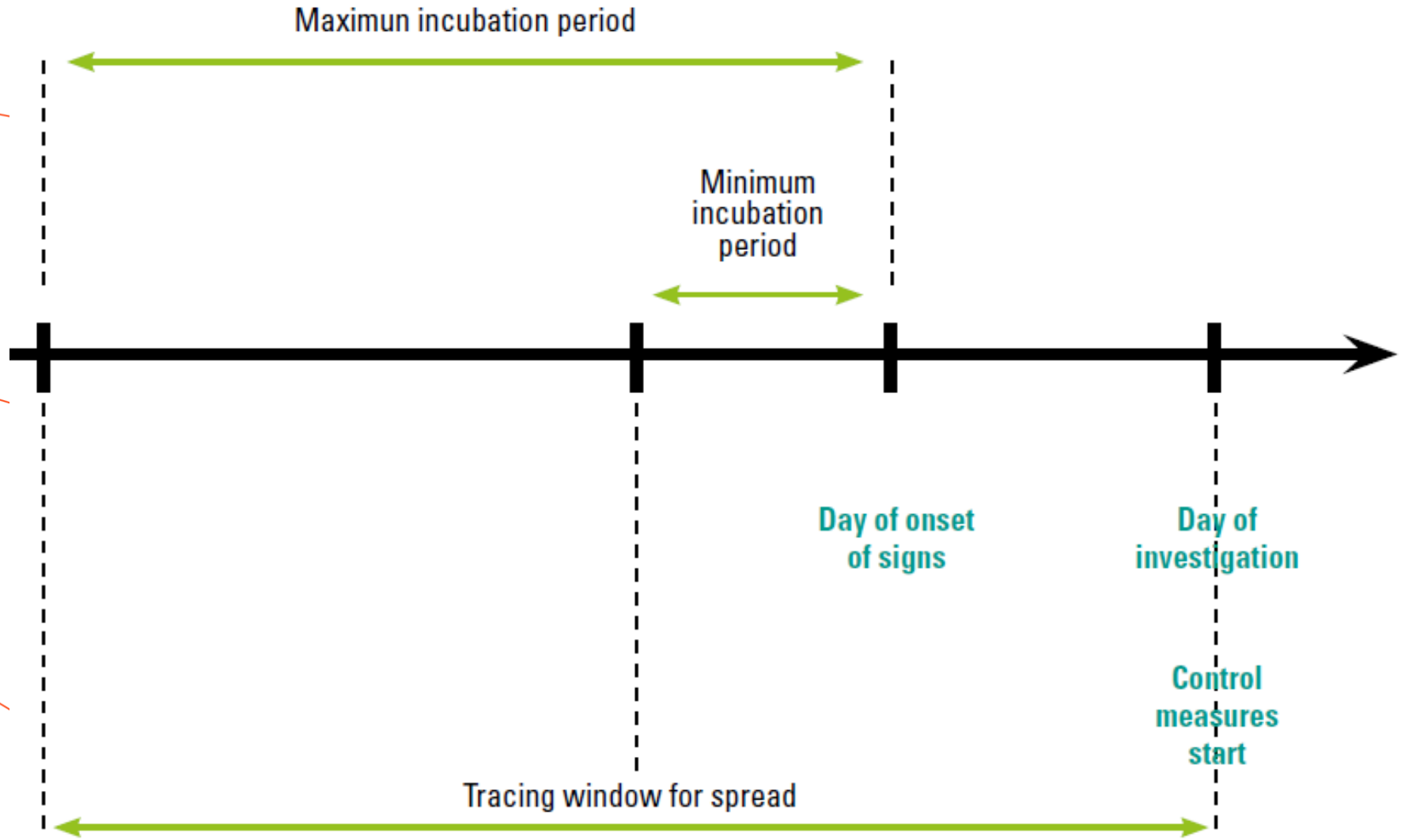
Investigate the outbreak

The most likely period of exposure



Investigate the outbreak

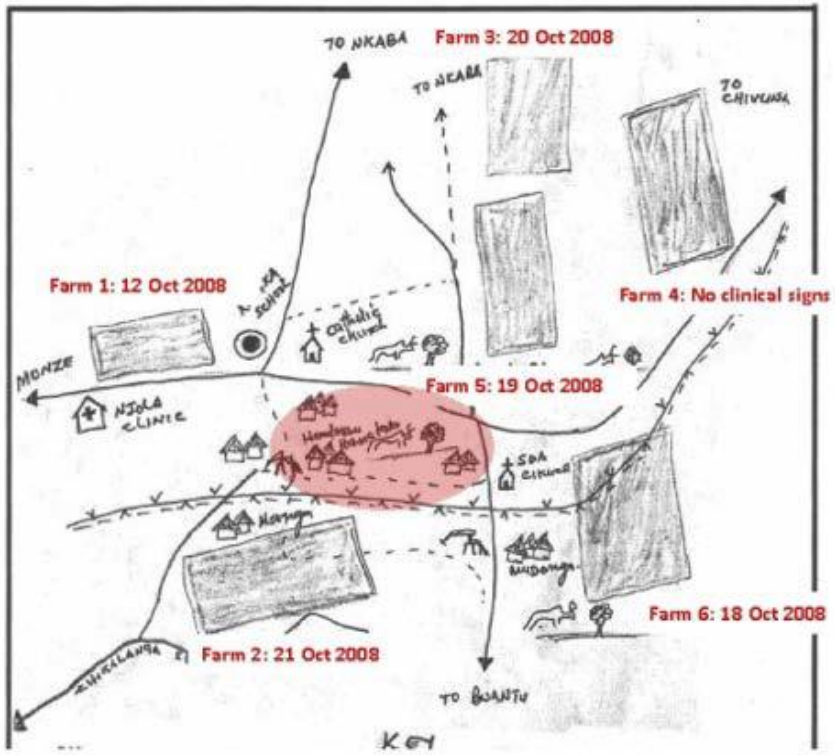
Tracing windows for spread

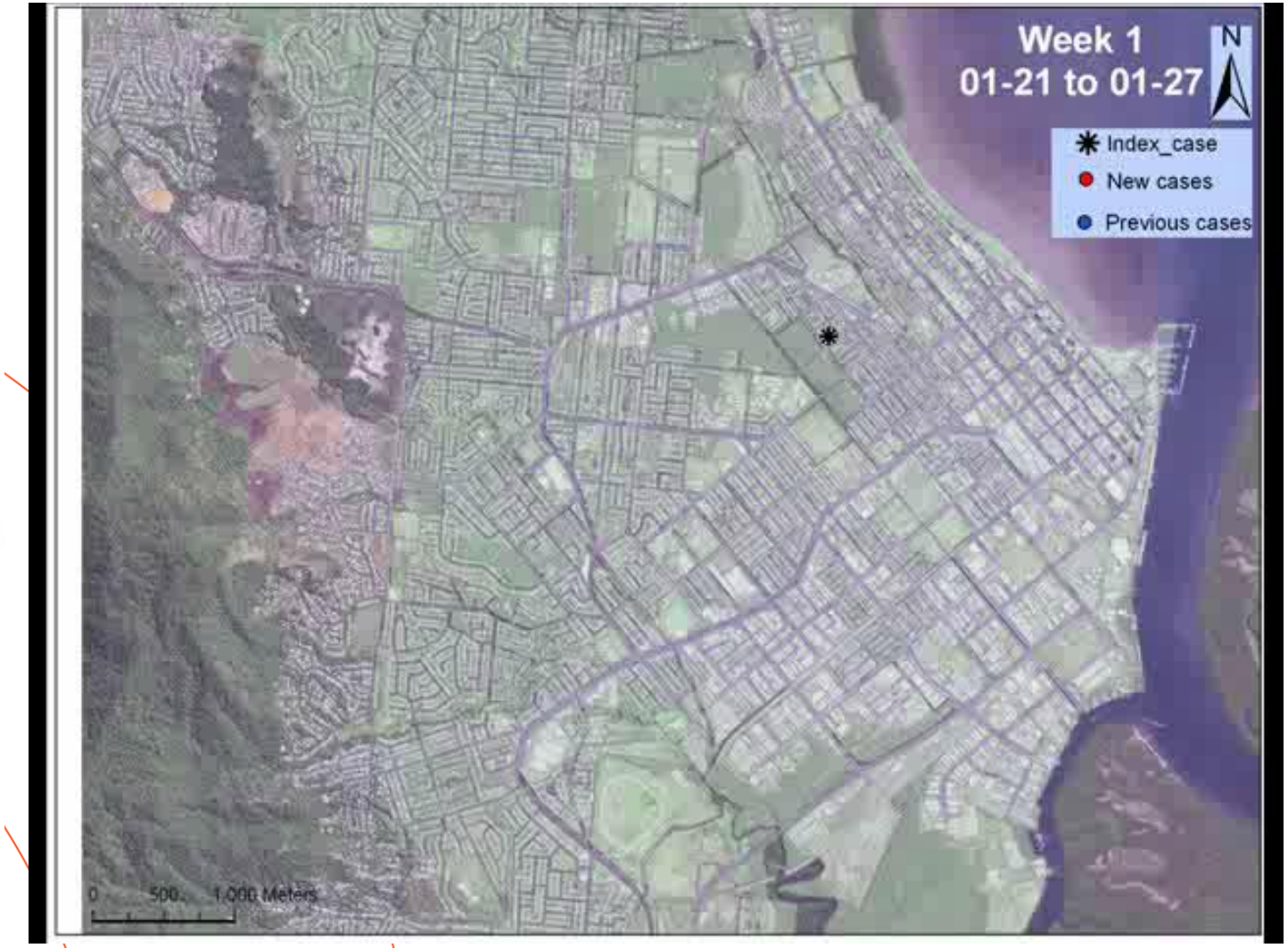


Investigate the outbreak

Space-time description

Ex. Spatio-temporal pattern of Dengue in Cairns, AUS





Investigate the outbreak

Develop hypotheses about the nature of exposure

- Generate hypotheses from descriptive investigation (animal, place, time)
- Literature search
- Subjective observations by the producer and other professionals are often useful
- Prioritise by their likelihood and focus on those with the highest priority until they are either more fully supported or refuted

Investigate the outbreak

Test your hypotheses

Because individuals are grouped (herds, flocks, pens)

- Case-control studies very useful
- Determine the differences between both affected and unaffected animals in terms of the factors they were exposed to

Case-control study

Retrospective (what happened?)

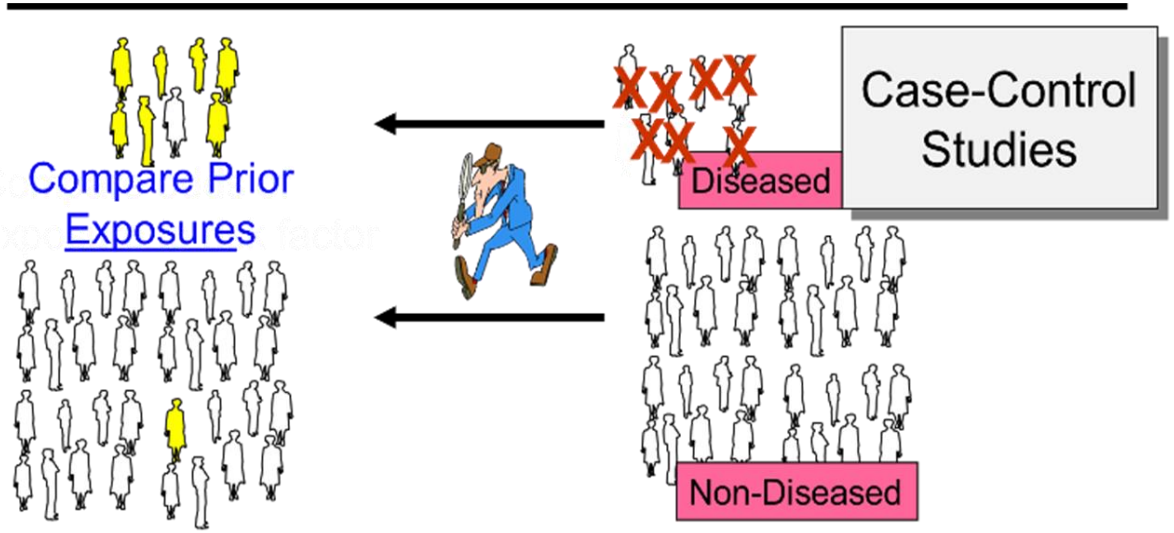
Define & identify cases from source population

Commonly, sample controls (non-cases) from source population, e.g. randomly

Quality depends on

- Selection of controls (from the population that gave rise to cases)
- Case and control definitions

Collect exposure history



Odds Ratio (OR)

		Disease		Total
		D+	D-	
Exposure	E+	a	b	a + b
	E-	c	d	c + d
Total		a + c	b + d	N

Odds of exposure in cases a/c

Odds of exposure in controls b/d

$$OR = \frac{a/c}{b/d} = \frac{a*d}{b*c}$$

Interpretation

- OR=1 no difference
- OR > 1
  - Disease associated with increased odds of exposure

  Ex. OR=2 the odds of exposure in the cases were twice the odds of exposure in the controls
- OR < 1
  - Protective factor associated with decreased odds of exposure

  Ex. OR=0.5 the odds of exposure in the cases were half the odds of exposure in the controls

Control Measures

Immediate:

- Measures to stop spread
  - Strict farm biosecurity
  - Animal movement control from the affected farms
  - Restricted movement of people
  - Strict biosecurity for the outbreak investigation team (leaving vehicles outside the farms, use of footbaths, washing and disinfecting equipment before leaving)
  - Ring vaccination for those diseases with good vaccines
  - Treatment of affected animals
- Risk communications

Long-term actions

- Policy interventions
- Update the disease control plans

Communicate findings

Report writing

- Preliminary report (short and concise document, 1-2 pages)
- Full report What should be in a good preliminary report?
- Title/author
- Introduction/background: who, what, when, where
- Objective of investigation: describe (retrospective), control (immediate response)
- Investigation methods and findings: how much, where from/to, transmission
- Sample collection and submission
- Preliminary control measures: actions taken and prescribed
- Recommended follow-up measures: control, surveillance

- Brief stakeholders and policy makers

Thank You