Canadian Food Inspection Agency | Agence canadienne d'inspection des aliments

Canadian Food Inspection Agency

Our vision:
To excel as a science-based regulator, trusted and respected by Canadians and the international community.

Our mission:
Dedicated to safeguarding food, animals and plants, which enhances the health and well-being of Canada's people, environment and economy.

Validity of conclusions in population-based surveillance

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Outline

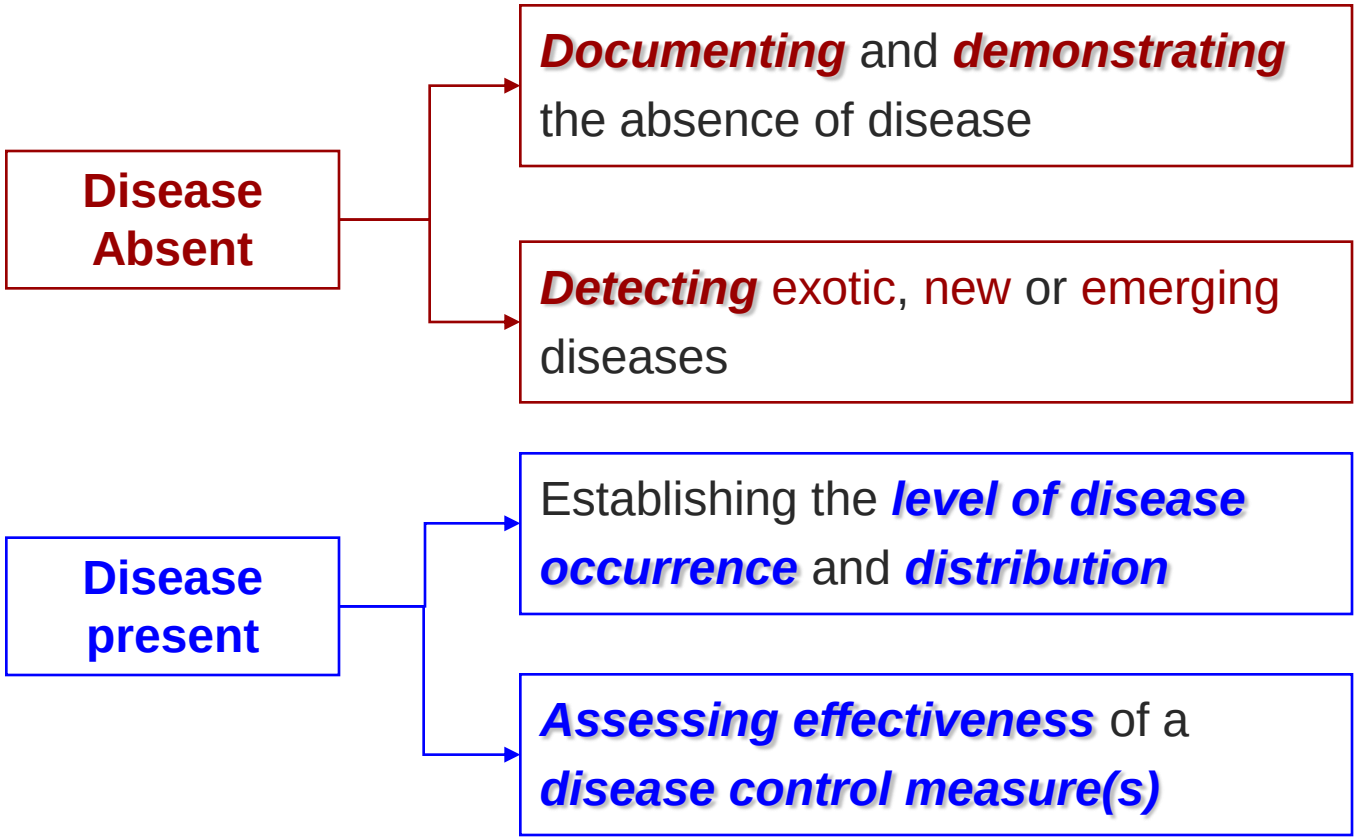
- Population-based surveillance
- Purpose of surveillance
- Surveillance process steps
- Sampling populations
  - Types of populations
  - Sampling techniques
- Forms of validity
- Statistical inference
- Example of application:
  - Bovine Serological Survey, 2007-2008

What do we mean by *"Population-based Surveillance"?*

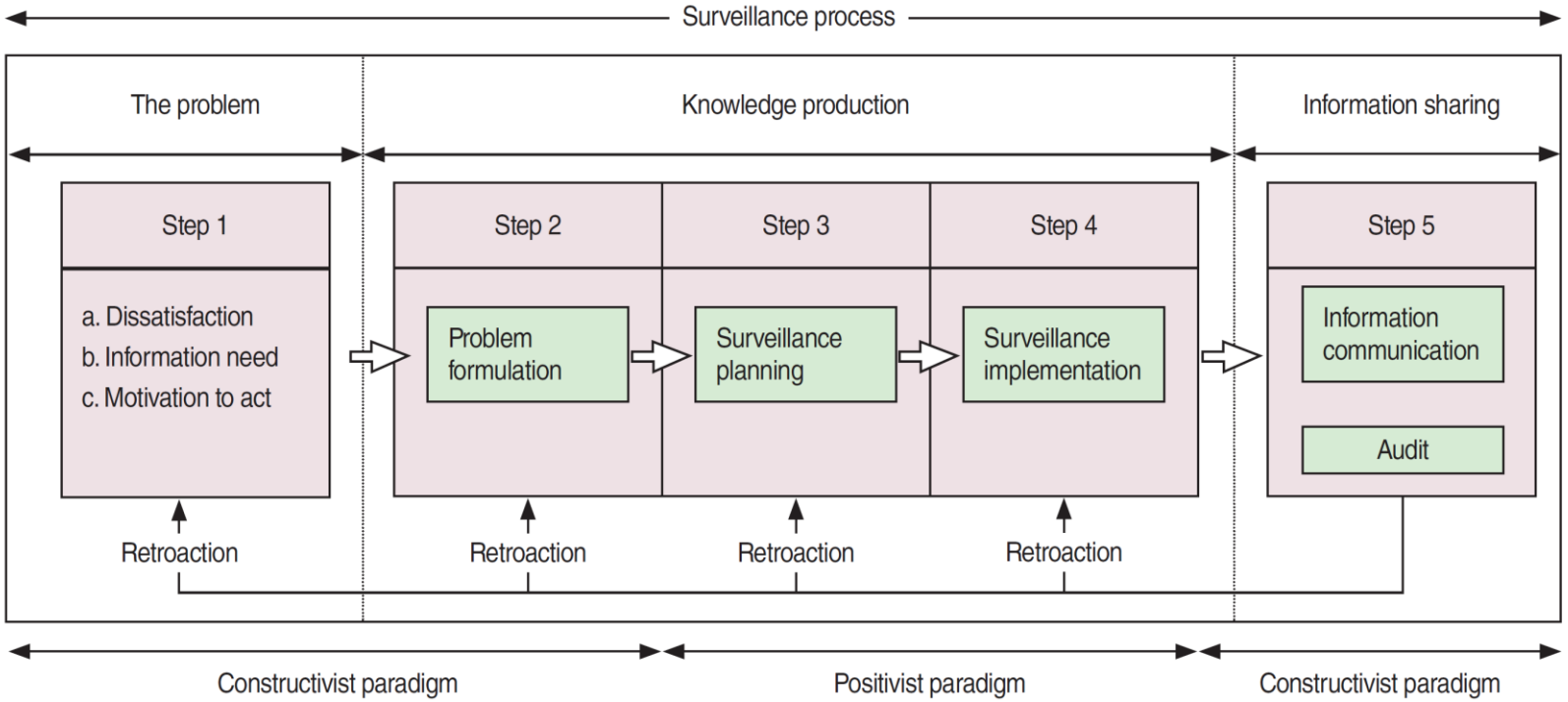
- Population-based Surveillance is a
  - Continuous and dynamic process of close observation of a **specific population** that includes ongoing :
    - **Data collection**,
    - **Data analysis**,
    - **Result interpretation**,
    - **Knowledge production**, and
    - **Timely information dissemination** to an appropriate audience

El Allaki, 2012

Purpose of surveillance



Surveillance process steps



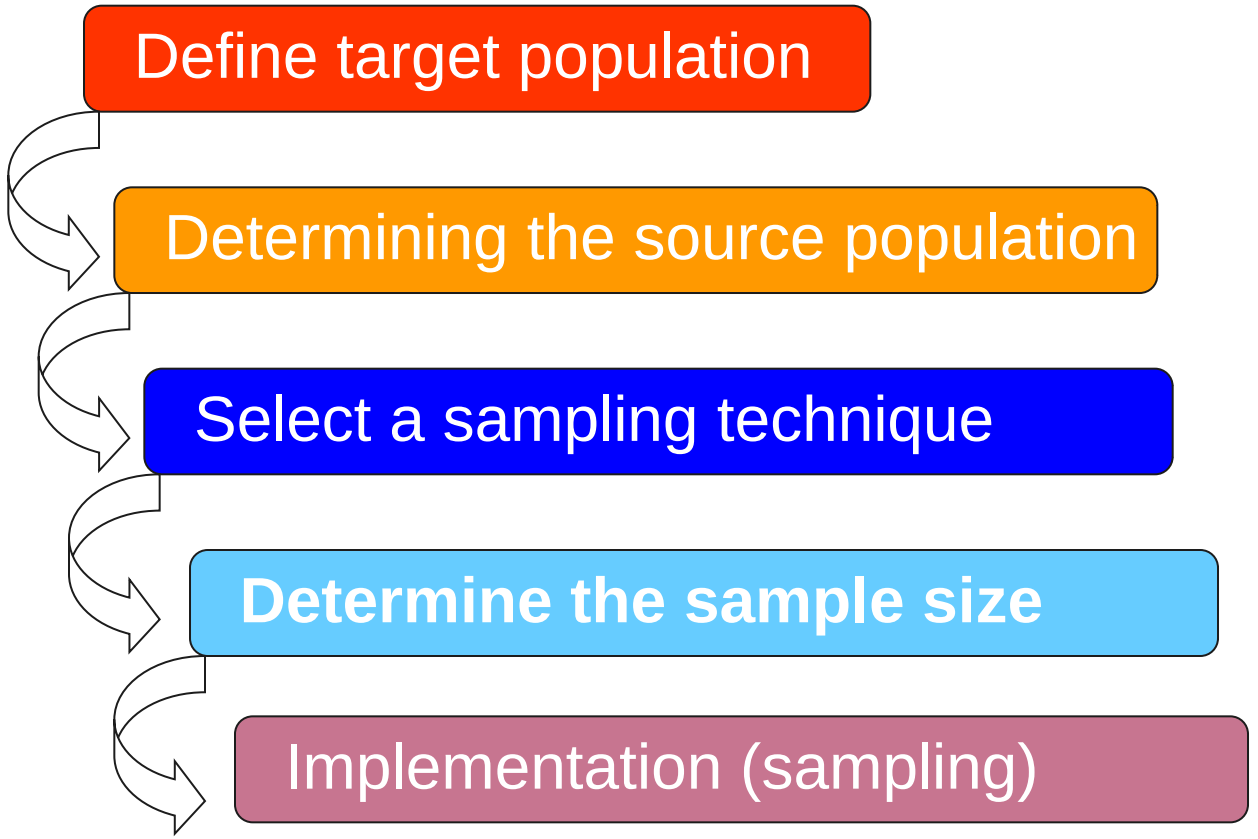
El Allaki, 2012

Sampling populations

- ***Census:*** observations made on every animal in the population of interest
  - Often, not possible to use for financial and logistical reasons.
    - » ***Sampling*** is the method of choice

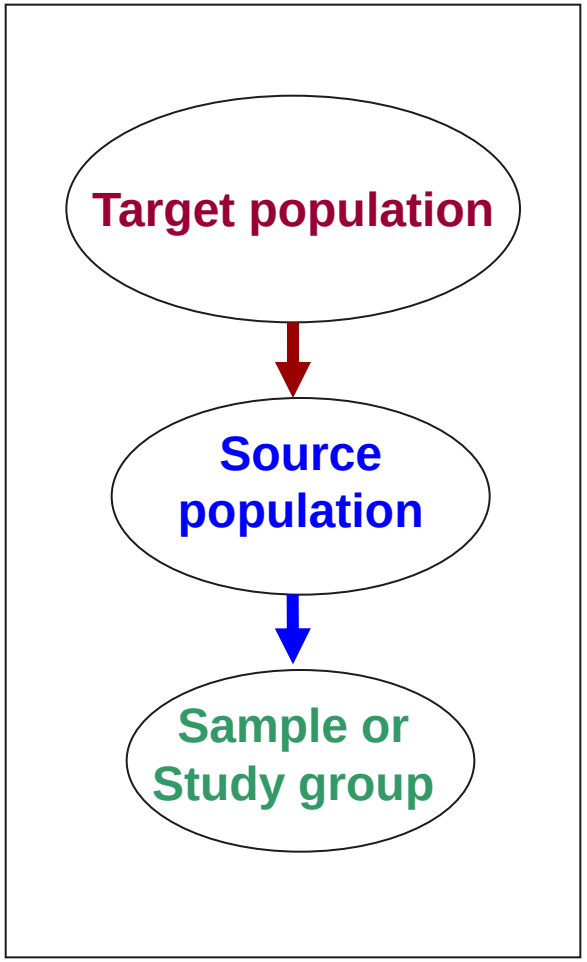
Sampling populations

- ***Sampling:***



Type of populations

- **Target population:** is the population to which surveillance conclusions are to be extrapolated
- **Source population:** represents the immediate population on which:
  - Surveillance conclusions will be applied
  - A sample to be selected
- **Sample or Study sample/group:** is a group of subjects members of the source population from which observations are made

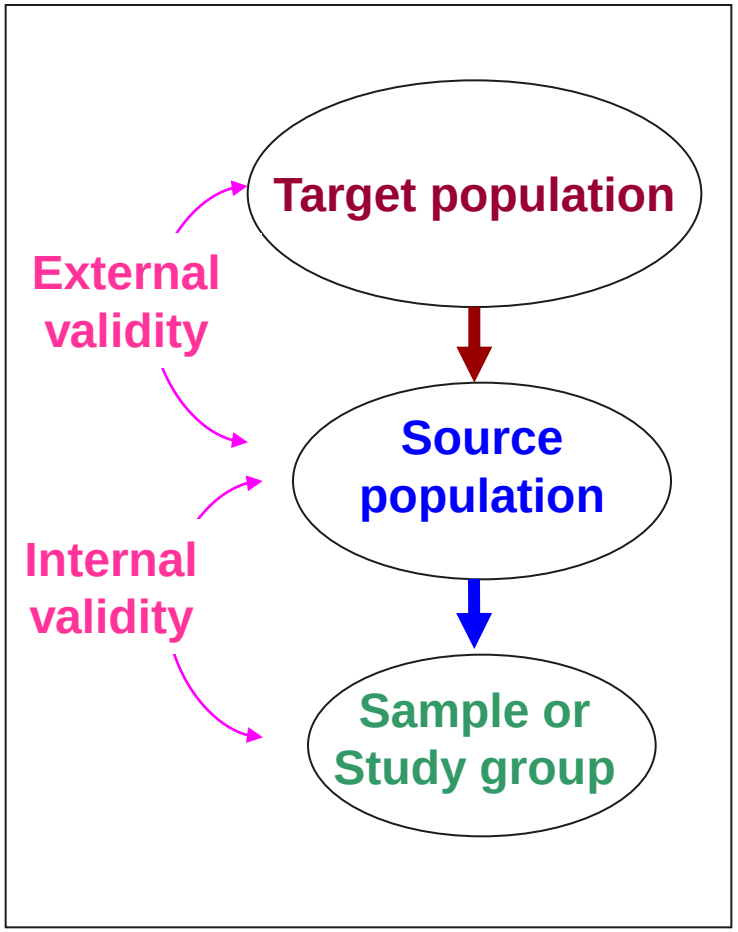


Sampling techniques

- Probability (random) sampling
  - Each member of the population has ***a known, non-zero probability*** of being selected in the sample
  - Requires a ***random selection process***
  - ***Representative*** sample from a population
- Non-probability sampling
  - In which the choice of the sample is left to the investigator

Internal Validity and External Validity

- **Validity** refers to the absence of a **systematic bias** (error) in the results
- **Internal validity** refers to the extent to which the sample estimate reflects the true value in the source population
  - Measurement free of systematic error
- **External validity** refers to the extent to which the sample estimate is generalizable to the target population



Statistical inference

- The fundamental question is: ‘’*Can we infer the population’s characteristics from the sample’s characteristics?”*

- Statistical Inference
  - A procedure by which we reach a **conclusion** about the **population** on the basis of the information contained in a **sample**

  - Requirement:
    - **Sample is representative** of the population
      - **Probability sampling is used**

Statistical inference

- Two ways to make inference

  - **Parameter estimation**
    - » Point estimation ($\bar{X}$ or p)
    - » Intervals estimation

  - **Hypothesis testing**

    E.g.

    - H0: Prevalence > x%
    - H1: Prevalence =< x%

Example of Bovine Serological Survey, 2007-2008

- The objective of this study was to demonstrate that the prevalence rates of
  - Brucellosis,
  - Bluetongue, and
  - Anaplasmosis

  are not higher than 0.02% in the Canadian cattle population with a statistical confidence of 95%.

Example of Bovine Serological Survey, 2007-2008

- Reference period: November 2007 to April 2008
- Target population: **Entire Canadian cattle population**
- Source population: Slaughtered **Cows and bulls >= 2 years of age**
- **Sample**
  - **Probability sampling** (systematic random sampling)
    - Sample every 5th cattle slaughtered (in Federally inspected plants)
  - Sample size
    - Stratified by province based on provincial fraction of on-farm cattle → **Geographical representation**
    - Quotas allocated by abattoir

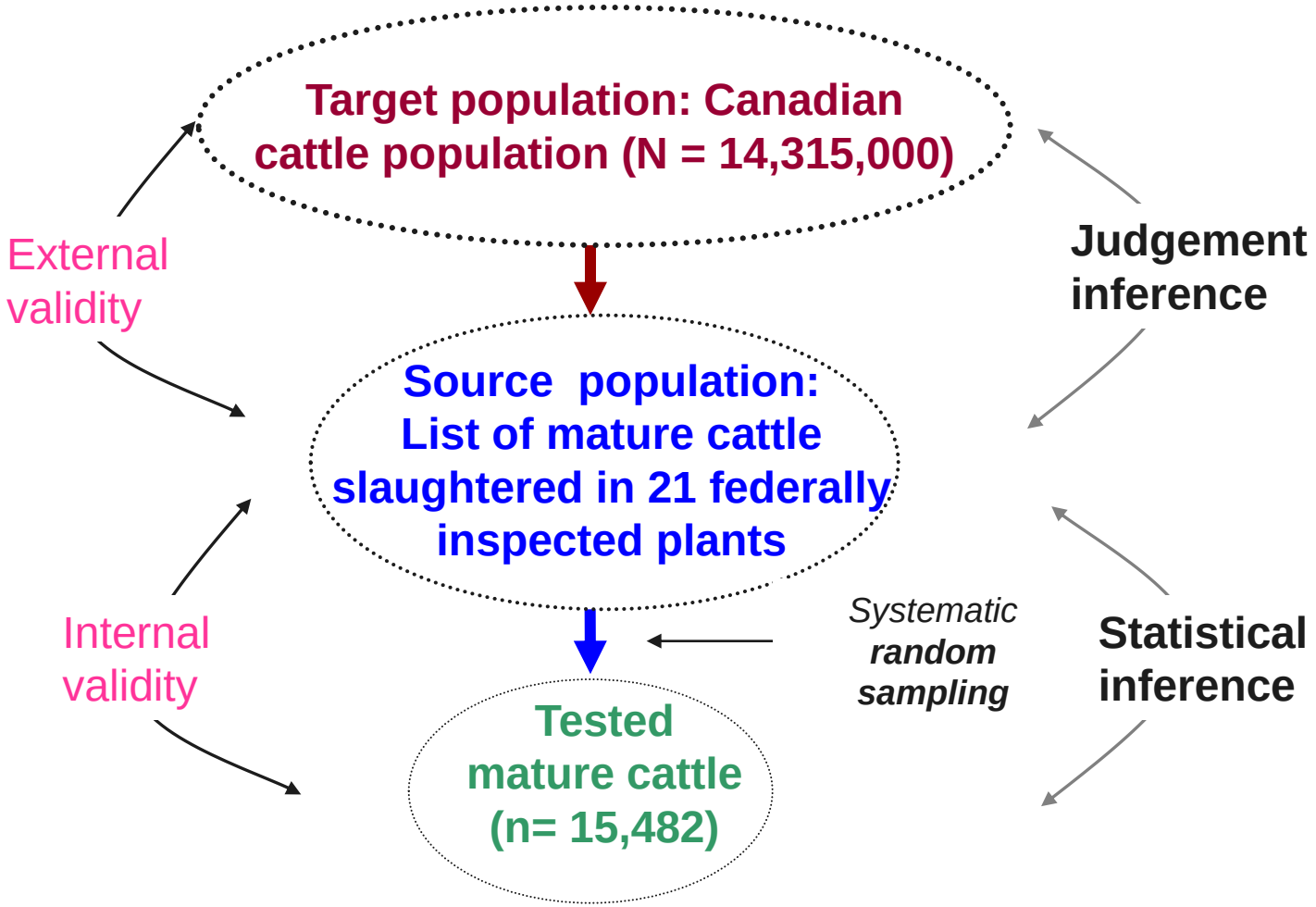
Paré et al. 2012

Bovine Serological Survey: Brucellosis results

- Brucellosis
  - Testing regime: FPA (screening test) → c-ELISA
  - 7 sero-reactors (all negative on c-ELISA)
  - Apparent prevalence: 0% (95%CI: 0% - 0.02%)
  - True prevalence: 0%

Paré et al. 2012

Example of Bovine Serological Survey, 2007-2008



Conclusions

- To ensure valid conclusions in surveillance
  - Before surveillance implementation
    - Define to which population the surveillance results will be applied
    - Use a valid surveillance design (case definition, probability sampling, representativeness, sample size, ovoid systematic errors-selection and information biases..etc)
  - Data analysis and reporting
    - Document and discuss why the results should be applied to the source & target populations
      - Statistical inference (check requirements, calculations)
      - Judgment inference (arguments)

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