MARK_RECAPTURE METHOD PETERSON METHOD

Lab Ecología general

Capture-recapture

- Peterson method
  - mark-recapture method

To estimate population size of any species, you can use a mark-recapture method which is based on the idea of simple algebra.

Where we do two surveys and in the first survey we mark (identify) each captured individuals in such a way that in the next time period we know that these individuals has already been seen in the first survey.

In the second survey we capture individuals and we identify the number of those that had been seen in the first survey. We need three information

- M = The number of individuals seen and marked in the first survey
- C = The total number of individuals captured in the second survey
- R = The number of recaptured individuals in the second survey

Lincoln-Peterson Method

- N = Number of individual in population
- M = the chosen sample, and Marked in the first survey
- C = Total number of Ind. captured in the second survey
- R = Number of Ind. recaptured in second survey

$$\frac{N}{M} = \frac{C}{R}$$

Re-arrange the formula

$$N = \frac{CM}{R}$$

Assumptions

- 1. All individuals have equal probability of being captured
- 2. NO change in ratio of mark and un-marked individuals, so large changes in mortality, natality, immigration and emmigration.
- 3. Marked individuals distribute themselves randomly with respect to unmarked individuals

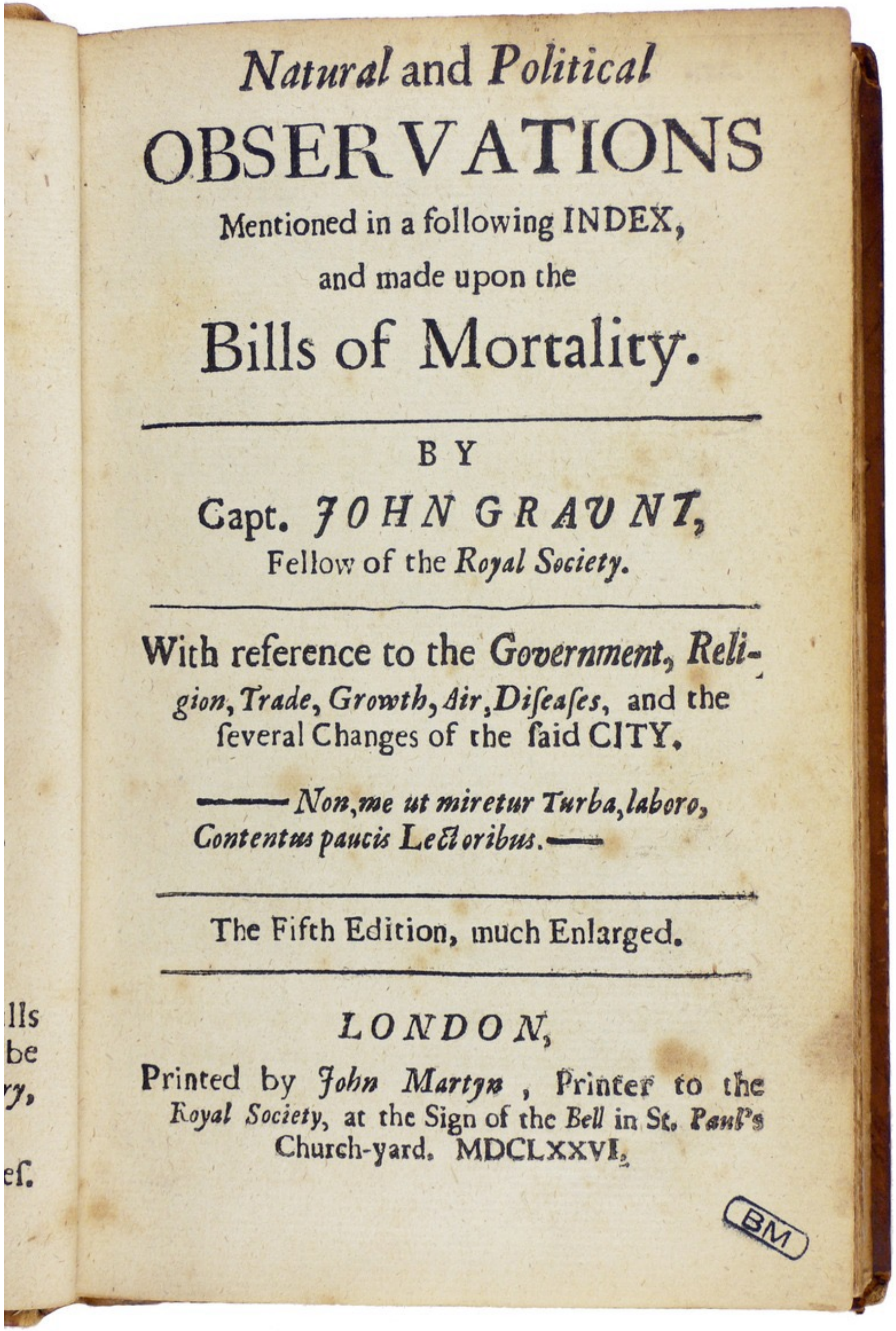
Unbiased Bias
Weber 1982

- Bias of the results as a consequence of small samples size

$$N = \frac{(C+1)(M+1)}{(R+1)}$$

Confidence Interval on the fraction of marked individuals

$$\frac{R}{C} \pm \left\{ z_{\alpha} \left[\sqrt{\frac{(1-\frac{R}{M})(\frac{R}{C})(1-\frac{R}{C})}{(C+1)}} \right] + \frac{1}{2C} \right\}$$



Natural and Political
OBSERVATIONS
Mentioned in a following INDEX,
and made upon the
Bills of Mortality.

BY
Capt. JOHN GRAUNT,
Fellow of the Royal Society.

With reference to the Government, Religion, Trade, Growth, Air, Diseases, and the several Changes of the said CITY.

——Non, me ut miretur Turba, laboro,
Contentus paucis Lectoribus.——

The Fifth Edition, much Enlarged.

LONDON,
Printed by John Martyn, Printer to the Royal Society, at the Sign of the Bell in St. Paul's Church-yard. MDCLXXVI.

This method was first used by John Graunt (1620-1674) to estimate the population of London, UK, published

See the following website for more information,

https://en.wikipedia.org/wiki/John_Graunt. John Graunt

is one the first demographer but his career was as a haberdasher
(seller of sewing materials, such as buttons, zippers, ribbons, etc).

The first known ecological example is from C. G. J. Petersen 1896 to estimate the population size of fish. *

Petersen, C. G. J. (1896). “The Yearly Immigration of Young Plaice Into the Limfjord From the German
Sea”, Report of the Danish Biological Station (1895), 6, 5–84.

Introduction

- Population dynamics studies the short and long-term changes in the size and age composition of populations, and the environment that influences those changes.
- Varied application
  - control of invasive species,
  - assessing population declines
  - determining population viability

Mark-Recapture

- Technique for estimating the population density of mobile animals.
- A sample of the population is captured, marked, and released.
- Assume:
  - marked individuals become randomly distributed
  - subsequent trapping is random
  - new sample contains representative proportion of marked an unmarked individuals.

- Two methods for estimating population size:
  - (1) **Petersen Method, and**
  - (2) **Modified Schnabel Method**
  - Both methods for closed populations
- No change in size due to births, deaths, immigration,or emigration.
- Open populations fluctuate in size and composition

Lincoln–Petersen method

Simple method with a single episode of marking animals and a second single episode of recapturing individuals

- Assumptions:
  - (1) Population is "closed", so N is constant.
  - (2) All animals have the same chance of getting caught
  - (3) Marking individuals does not affect catchability.
  - (4) Animals do not lose marks
  - (5) All marks are reported on discovery

What makes a population closed?

- Dispersal barriers
- Philopatry
- Large surveyed area

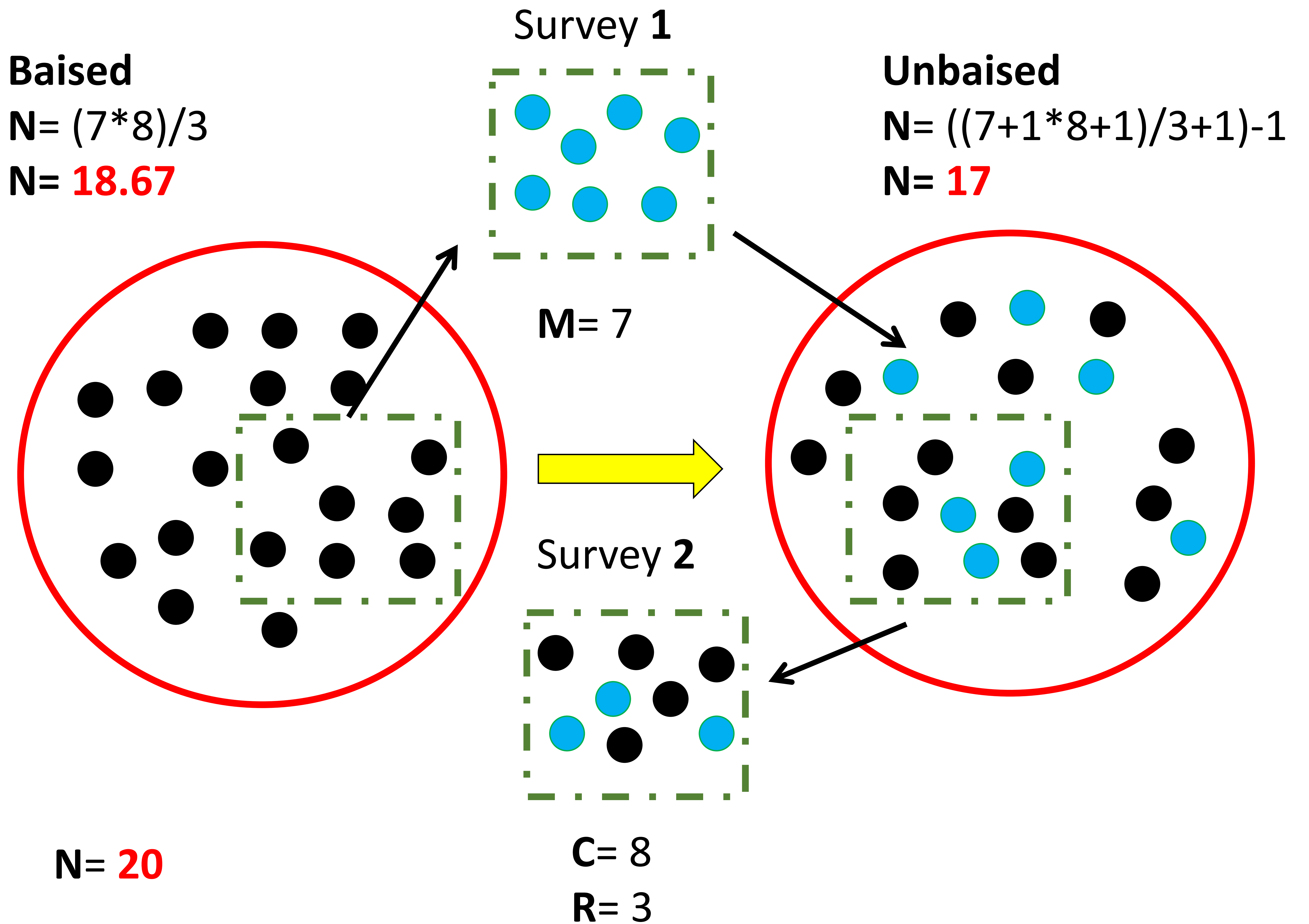
- Slow reproductive/death rate
- Short time between surveys

Equation

$$N = \frac{MC}{R},$$

- N = Population size
- M = Total captured and marked on first visit
- C = Number captured on the second visit
- R = Number recaptured

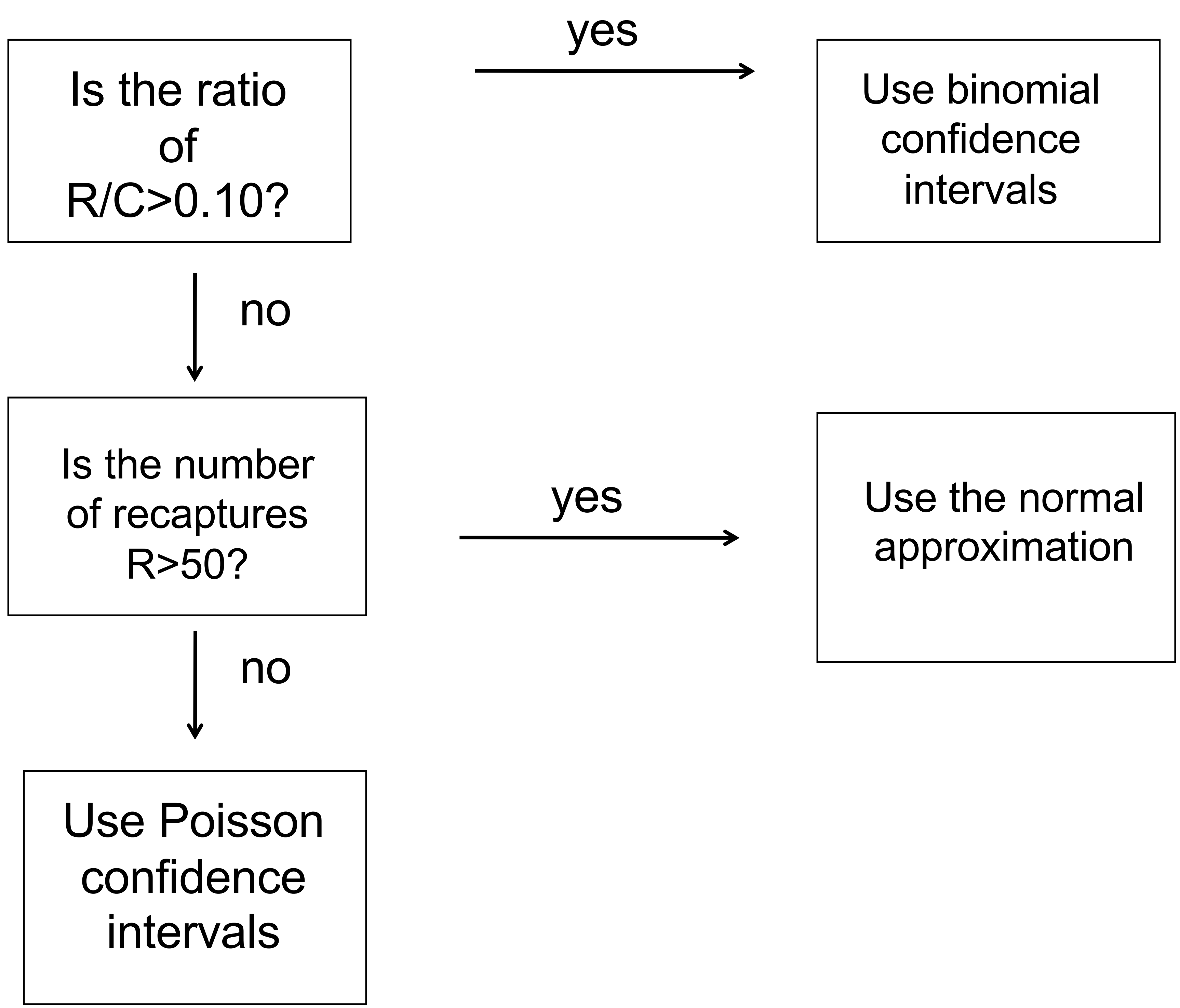
$$N = \frac{(M+1)(C+1)}{R+1} - 1,$$


Survey 1
Baised
N= (7*8)/3
N= 18.67
Unbaised
N= ((7+1*8+1)/3+1)-1
N= 17
M= 7
Survey 2
N= 20
C= 8
R= 3

When would Petersen give you a bad estimate?

- Population not closed
- Marked animals likely to be re-trapped
- Unmarked animal unlikely to be re-trapped
- Marked animals likely to die
- Marks fall off
- Positive:
  - Simplest model
  - Can estimate size in two visits
- Negative:
  - Short time studies
  - Assumes closed population
  - Limited number of parameters

Confidence Intervals



Poisson example

Confidence intervals for R

- Lower 95%= 0.818

N= 7*8/0.818= **68.5**

- Upper 95%= 8.102

N= 7*8/8.102= **6.92**

M=7

C=8

R=3

$$N = \frac{MC}{R},$$

Normal Approximation

$$\frac{R}{C} \pm \{Z \propto [\sqrt{\frac{(1-f)\left(\frac{R}{C}\right)\left(1-\frac{R}{C}\right)}{(C-1)}}] + \frac{1}{2C}$$

f= fraction of total populations sampled in the second sample = R/M

1/2C= correction for continuity

Z_{α}= standard normal derivate

= 1.96 for 95%

= 2.576 for 99%

$$\frac{R}{C} \pm Z \propto \sqrt{\frac{\left(\frac{R}{C}\right)\left(1-\frac{R}{C}\right)}{(C-1)}}$$

Large sample and large population s

ize

Example

M= 1800
C= 800
R=73

$$\frac{73}{800} \pm \{1.96[\sqrt{\frac{\left(1-\frac{73}{1800}\right)\left(\frac{73}{800}\right)\left(1-\frac{73}{800}\right)}{(800-1)}}] + \frac{1}{2(800)}$$

95% confidence intervals= 0.09125 ± 0.020176

R/C=0.07107 and 0.222426

$$\frac{R}{C} \pm \{Z \propto [\sqrt{\frac{(1-f)\left(\frac{R}{C}\right)\left(1-\frac{R}{C}\right)}{(C-1)}}] + \frac{1}{2C}$$

$$N = \frac{CM}{R}$$

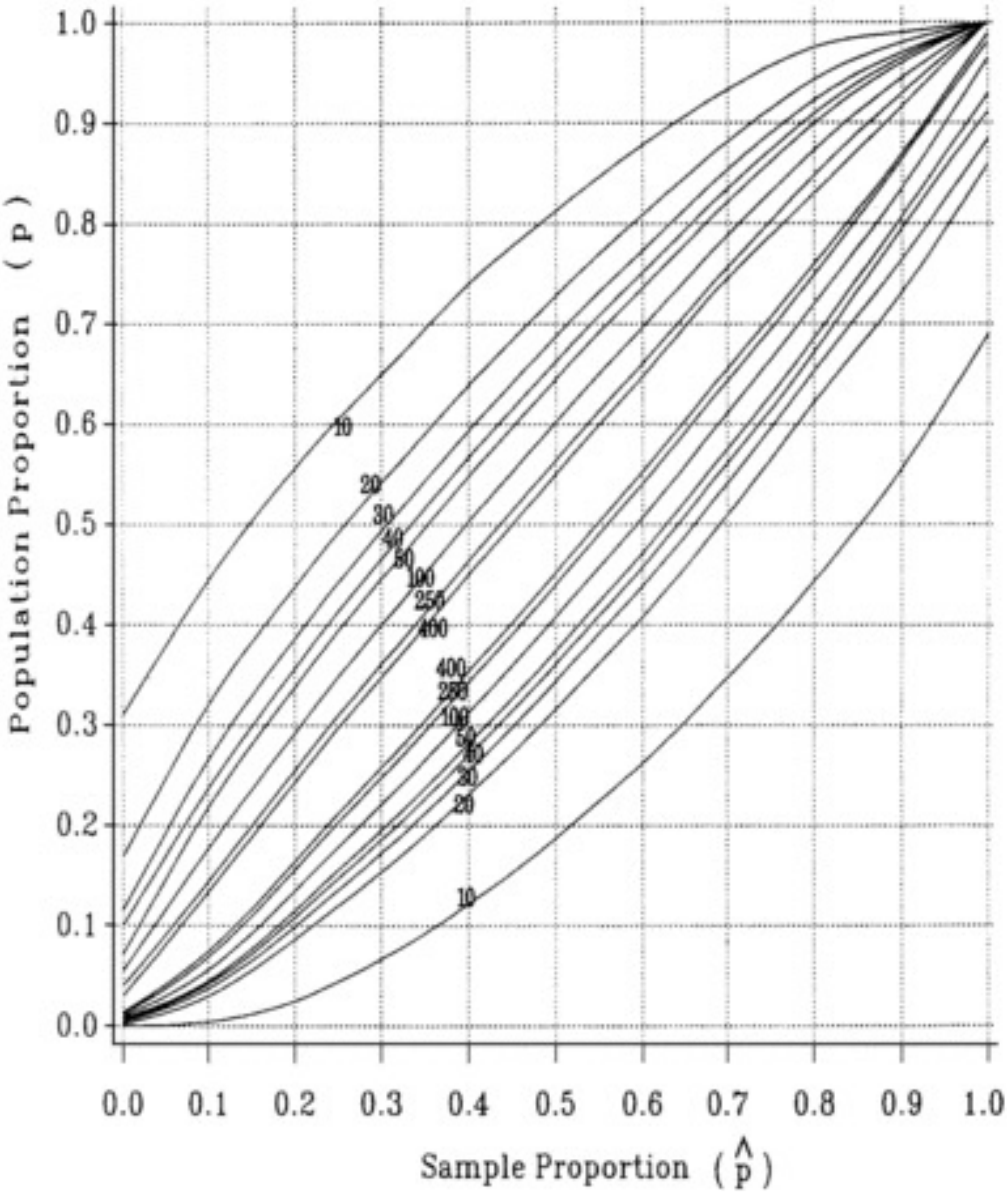
$$\frac{C}{R} = \frac{1}{R/C}$$

Upper 95%=

$$\frac{1}{0.07107}(1800) = 25{,}326$$

Lower 95%=

$$\frac{1}{0.111426}(1800) = 16{,}154$$



Population Proportion (p)
Sample Proportion (p̂)
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1.0
10
20
30
40
50
100
250
400

Binomial example

- R/C= 14/22= 0.64

M= 50
C= 22
R=14

Lower 95%= 0.83

Upper 95%= 0.40

$$N = \frac{1}{0.83}(50) = 60$$

$$N = \frac{1}{0.40}(50) = 125$$