Sampling II

Mohr

Assumptions

Metrics

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Summar

Sampling and Sample Size Issues II

Michael Mohr

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PSC GSI Workshop 2, 2007

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1 Assumptions

2 Metrics

- lacksquare Probability of detecting ≥ 1 individuals from stock
- Coefficient of variation of \hat{p}
- Confidence interval width for p
- Minimum detectable difference between p_1 and p_2

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1 Assumptions

- 2 Metrics
 - $lue{}$ Probability of detecting ≥ 1 individuals from stock
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 - 3 Example application

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1 Assumptions

- 2 Metrics
 - lacksquare Probability of detecting ≥ 1 individuals from stock
 - Coefficient of variation of \hat{p}
 - Confidence interval width for p
 - Minimum detectable difference between p_1 and p_2
- 3 Example application
- 4 Additional comments

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All collected tissues processed and classified

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Summary

- <u>All</u> collected tissues processed and classified
- <u>All</u> classifications are 100% accurate

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Summary

All collected tissues processed and classified

- All classifications are 100% accurate
- Type I and Type II error rates apply to p_i not $\{p_i\}$

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All collected tissues processed and classified

■ All classifications are 100% accurate

■ Type I and Type II error rates apply to p_i not $\{p_i\}$

Simple random sampling within each stratum

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Summar

All collected tissues processed and classified

- All classifications are 100% accurate
- Type I and Type II error rates apply to p_i not $\{p_i\}$
- Simple random sampling within each stratum
- Sampling fraction is negligible (n relative to C, or N)

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Summary

Binomial model: $P(Y = y) = \binom{n}{y} p^y (1-p)^{n-y}$ implies

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Summary

Binomial model:
$$P(Y = y) = \binom{n}{y} p^y (1-p)^{n-y}$$
 implies

$$Q = P(Y \ge 1) = 1 - P(Y = 0) = 1 - (1 - p)^n$$

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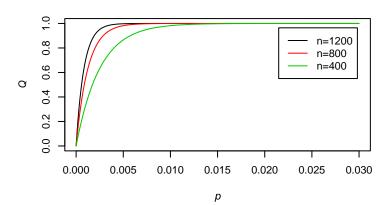
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Binomial model:
$$P(Y = y) = \binom{n}{y} p^y (1-p)^{n-y}$$
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$$n = \log(1 - Q)/\log(1 - p)$$

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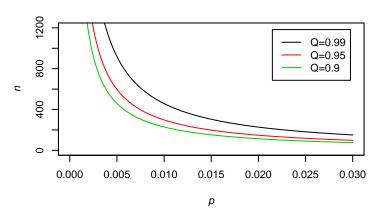
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$$CV = \sqrt{V(\hat{p})}/p = \sqrt{(1-p)/(np)}$$

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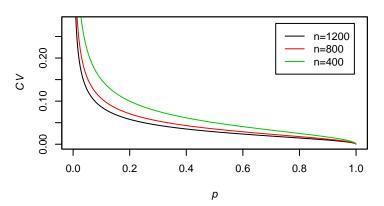
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$$CV = \sqrt{V(\hat{p})}/p = \sqrt{(1-p)/(np)}$$



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$$n = (1 - p)/(p \cdot CV^2)$$

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Binomial model: $V(\hat{p}) = p(1-p)/n$ implies

$$n = (1 - p)/(p \cdot CV^2)$$

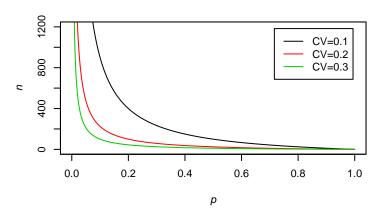
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Binomial model + normal approx. for \hat{p} implies

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$$w = 2 \cdot Z_{1-\alpha/2} \cdot \sqrt{p(1-p)/n}$$

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$$\mathbf{w} = 2 \cdot Z_{1-\alpha/2} \cdot \sqrt{p(1-p)/n}$$

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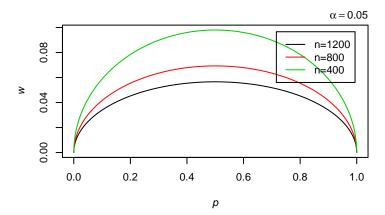
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$$w = 2 \cdot Z_{1-\alpha/2} \cdot \sqrt{p(1-p)/n}$$



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$$n = 4 \cdot Z_{1-\alpha/2}^2 \cdot p(1-p)/w^2$$

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Binomial model + normal approx. for \hat{p} implies

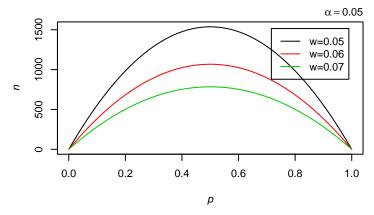
$$n = 4 \cdot Z_{1-\alpha/2}^2 \cdot p(1-p)/w^2$$

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Minimum detectable difference between p_1 and p_2

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Binomial model + normal approx. for \hat{p}_1 and \hat{p}_2 implies

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Summary

Binomial model + normal approx. for \hat{p}_1 and \hat{p}_2 implies

$$\begin{split} n &= (n'/4) \left[1 + \sqrt{1 + (4/(n'd))} \right]^2, \\ n' &= \left[Z_{1-\alpha} \sqrt{2 \overline{p} (1 - \overline{p})} + Z_{\text{power}} \sqrt{p_1 (1 - p_1) + p_2 (1 - p_2)} \right]^2 / d^2. \end{split}$$

with
$$p_1 > p_2$$
, $d = p_1 - p_2$, $\bar{p} = (p_1 + p_2)/2$.

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$$n = (n'/4) \left[1 + \sqrt{1 + (4/(n'd))} \right]^2,$$

$$n' = \left[Z_{1-\alpha}\sqrt{2\overline{p}(1-\overline{p})} + Z_{\text{power}}\sqrt{p_1(1-p_1) + p_2(1-p_2)}\right]^2/d^2.$$

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Binomial model + normal approx. for \hat{p}_1 and \hat{p}_2 implies

$$\begin{split} & n = (n'/4) \left[1 + \sqrt{1 + (4/(n'd))} \right]^2, \\ & n' = \left[Z_{1-\alpha} \sqrt{2 \overline{\rho} (1 - \overline{\rho})} + Z_{\text{power}} \sqrt{\rho_1 (1 - \rho_1) + \rho_2 (1 - \rho_2)} \right]^2 / d^2. \end{split}$$

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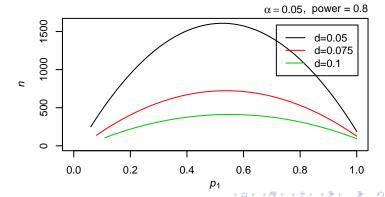
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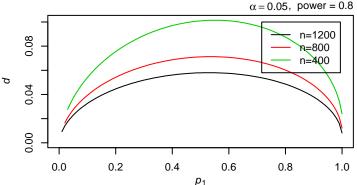
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Example Application: I

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Goal

 \hat{p} for all stocks by time, area, fishery

Example Application: I

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Comments

Summar

- \hat{p} for all stocks by time, area, fishery
- Statistical objectives (each stratum)
 - $Q \ge 0.999$ for $p \ge 0.01$
 - $CV \le 0.20$ for $p \ge 0.03$

Example Application: I

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- \hat{p} for all stocks by time, area, fishery
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 - $Q \ge 0.999$ for $p \ge 0.01$
 - $CV \le 0.20$ for $p \ge 0.03$
- Minimum *n* per stratum
 - ≈ 800

Example Application: II

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Application

Comments

Summar

- \hat{p} for all stocks by time, area, fishery
- Statistical objectives (each stratum)
 - $Q \ge 0.999$ for $p \ge 0.01$
 - $CV \le 0.20$ for $p \ge 0.03$
 - $w \le 0.06$ for $p \ge 0.01$ with $\alpha = 0.05$

Example Application: II

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Summar

- \hat{p} for all stocks by time, area, fishery
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 - $w \le 0.06$ for $p \ge 0.01$ with $\alpha = 0.05$
- Minimum *n* per stratum
 - ≈ 1070

Example Application: III

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Comment

Summar

- \hat{p} for all stocks by time, area, fishery
- compare p inshore/offshore
- Statistical objectives (each stratum)
 - $Q \ge 0.999$ for $p \ge 0.01$
 - $CV \le 0.20$ for $p \ge 0.03$
 - $w \le 0.06$ for $p \ge 0.01$ with $\alpha = 0.05$
 - power \geq 0.80 to detect $d=p_{off}-p_{in}$ with $\alpha=0.05$

Example Application: III

Sampling II

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Comment

Summa

- \hat{p} for all stocks by time, area, fishery
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 - $w \le 0.06$ for $p \ge 0.01$ with $\alpha = 0.05$
 - power \geq 0.80 to detect $d = p_{off} p_{in}$ with $\alpha = 0.05$
 - assume $p_{off} \ge 0.03$, and $p_{in} \le p_{off}/2$

Example Application: III

Sampling II

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 - power \geq 0.80 to detect $d = p_{off} p_{in}$ with $\alpha = 0.05$
 - assume $p_{off} \ge 0.03$, and $p_{in} \le p_{off}/2$
- Minimum n_{in} , n_{off} per stratum
 - ≈ 1350

Age-specific stock composition

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Summary

Chinook

- distribution is stock-age-specific
- assessment requires stock-age-specific catch

Age-specific stock composition

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Summary

Chinook

- distribution is stock-age-specific
- assessment requires stock-age-specific catch

■ Minimum *n*

- treat stock-age components as "separate stocks"
- apply sample size formulas

Age-specific stock composition

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Summary

Chinook

- distribution is stock-age-specific
- assessment requires stock-age-specific catch

■ Minimum *n*

- treat stock-age components as "separate stocks"
- apply sample size formulas

Additional requirements

- GSI individual assignment (versus MSA)
- age assignment (scale collection and reading)
- both assignments assumed 100% accurate

Sampling II

Comments

Size-selective fishery (for a stratum)

$$p_i = \frac{C_i}{\sum C_k} = \frac{N_i^* \alpha_i q_i f \ell_i}{\sum N_k^* \alpha_k q_k f \ell_k} = \frac{N_i^* \alpha_i q_i \ell_i}{\sum N_k^* \alpha_k q_k \ell_k}$$

Sampling II

Comments

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Sampling II

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• Assume $q_1 = q_2 = q_3 = \dots$

$$p_i = \frac{N_i^* \alpha_i \ell_i}{\sum N_k^* \alpha_k \ell_k}$$

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• Assume $q_1 = q_2 = q_3 = \dots$

$$p_i = \frac{N_i^* \alpha_i \ell_i}{\sum N_k^* \alpha_k \ell_k}$$

■ Variation in p_i across strata (at time t)

numerator: stock i

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Size-selective fishery (for a stratum)

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■ Variation in p_i across strata (at time t)

numerator: stock i

denominator: other stocks, e.g. 50/100 vs 50/1000

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• Assume $q_1 = q_2 = q_3 = \dots$

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numerator: stock i

denominator: other stocks, e.g. 50/100 vs 50/1000

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Quota management: $\hat{p}_i/\hat{\ell}_i$

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Quota management: $\hat{p}_i/\hat{\ell}_i$

Cohort analysis: $[\hat{C}\hat{p}_i/\hat{\ell}_i]$

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Summar

Quota management: $\hat{p}_i/\hat{\ell}_i$

Cohort analysis: $[\hat{C}\hat{p}_i/\hat{\ell}_i]$

Seasonal management: $[\widehat{C}\widehat{p}_i/\widehat{\ell}_i]$ / d

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Quota management: $\hat{p}_i/\hat{\ell}_i$

Cohort analysis: $[\hat{C}\hat{p}_i/\hat{\ell}_i]$

Seasonal management: $[\widehat{C}\hat{p}_i/\hat{\ell}_i]$ / d

Distribution studies: $[\widehat{C}\widehat{p}_i/\widehat{\ell}_i]/\widehat{f}$

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Summar

Quota management: $\hat{p}_i/\hat{\ell}_i$

Cohort analysis: $[\hat{C}\hat{p}_i/\hat{\ell}_i]$

Seasonal management: $[\widehat{C}\widehat{p}_i/\widehat{\ell}_i]$ / d

Distribution studies: $[\hat{C}\hat{p}_i/\hat{\ell}_i]/\hat{f}$

- p itself not necessarily quantity of interest
- Compounded estimates compound error

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Comments

Summary

■ Binomial-based *n* formulas useful for planning

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${\sf Sampling}\ {\sf II}$

Mohr

Assumptions

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Detection
CV
CI

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