Estimation of Rainbow Trout Abundance in Upper Niagra Springs Pond using the Single Census Mark-Recapture Methods

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Introduction

Warren *et al.* (2004) examined the population of Rainbow Trout (Oncorhynchus mykiss) in the Upper Niagara Springs Pond in 2000. Fish were captured at two times by using an electrofishing unit attached to a driftboat. The capture history of all fish examined in the two samples that were 100 mm and longer is in RBTroutUNSP.

1. Use these data to answer the following questions.

- Create a summary of the capture histories. From your capture history summary assign values to each of M, n, and m Construct an appropriate population estimate, with a 95% confidence interval, for Upper Niagara Springs Pond Rainbow Trout in 2000.
- Carefully interpret the results. Which method did you use to construct the confidence interval? Explain why you chose that method.

Data Collection and Importation

```
library(tidyverse)
library(car)
library(knitr)
```

```
trout_data <- read_csv('data-raw/RBTroutUNSP.csv')
view(trout_data)
trout_data |>
  str()
```

```
spc_tbl_ [173 x 2] (S3: spec_tbl_df/tbl_df/tbl/data.frame)
 $ first : num [1:173] 1 1 1 1 1 1 1 1 1 1 ...
 $ second: num [1:173] 1 0 0 0 0 0 0 0 1 0 ...
 - attr(*, "spec")=
  .. cols(
  ..   first = col_double(),
  ..   second = col_double()
  .. )
 - attr(*, "problems")=<externalptr>
```

Summary of Capture of Histories

Summary of the Rainbow Trout Abundance data

```
trout_data |>
  summary() |>
  kable(
    align = 'lccr',
    caption = 'Summary of the Rainbow Trout Abundance'
  )
```

Table 1: Summary of the Rainbow Trout Abundance

first	second
Min. :0.0000	Min. :0.0000
1st Qu.:0.0000	1st Qu.:0.0000
Median :0.0000	Median :1.0000
Mean :0.4277	Mean :0.6358

first	second
3rd Qu.:1.0000	3rd Qu.:1.0000
Max. :1.0000	Max. :1.0000

Summary of the First Time Capture History

```
trout_data |>
  summarise(
    mean_first_year = mean(first),
    median_first_year = median(first),
    max_first_year = max(first),
    min_first_year = min(first)
  ) |>
  kable(
    caption = 'Summary of the First Time Capture History'
  )
```

Table 2: Summary of the First Time Capture History

mean_first_year	median_first_year	max_first_year	min_first_year
0.4277457	0	1	0

Summary of the Second Time Capture History

```
trout_data |>
  summarise(
    mean_second_year = mean(second),
    median_second_year = median(second),
    max_second_year = max(second),
    min_second_year = min(second)
  ) |>
  kable(
    caption = 'Summary of the Second Time Capture History'
  )
```

Table 3: Summary of the Second Time Capture History

mean_second_year	median_second_year	max_second_year	min_second_year
0.6358382	1	1	0

Number of Tagged and Un-tagged Fish caught the First time

```
trout_data |>
  group_by(first) |>
  summarise(count = n()) |>
  kable(
    caption = 'Summary of Tagged and Untagged Fish caught the First time'
  )
```

Table 4: Summary of Tagged and Untagged Fish caught the First time

first	count
0	99
1	74

Number of Tagged and Un-tagged Fish caught the Second time

```
trout_data |>
  group_by(second) |>
  summarise(count = n ()) |>
  kable(
    caption = 'Summary of Tagged and Untagged Fish caught the Second Time'
  )
```

Table 5: Summary of Tagged and Untagged Fish caught the Second Time

second	count
0	63
1	110

Construction of the Population Estimate Key using the Lincoln-Peterson Estimator

In this study:

- N is the total number of fish in the population.
- C is the total number of fish captured in both samples.
- R is the number of recaptures.

To assign these values, we can calculate them directly from our data:

```
# Assign values to N, C, and R
C <- nrow(trout_data) # Total captures from both samples
R <- sum(trout_data$first == 1 & trout_data$second == 1) # Sum of Recaptures
N <- C + R # Total population estimate (using lincoln-petersen estimator)
```

Calculation of Population Estimate using Lincoln-Petersen Estimator

Using the Lincoln-Petersen estimator, we can estimate the population size and calculate a confidence interval. The formula for estimating population size is:

$N = (C_1 + 1)\ (C_2 + 1)\ /\ (R + 1)$ - 1

Where:

- C is captures in the first sample,
- C is captures in the second sample,
- R is recaptures.

We will also calculate a confidence interval using a normal approximation method.

```
# Calculate population estimate using Lincoln-Petersen Estimator
C1 <- sum(trout_data$first == 1)
C2 <- sum(trout_data$second == 1)

estimate_size <- ((C1 + 1) * (C2 + 1)) / (R + 1) - 1
```

Calculation of Standard Error and Confidence Interval

```r
# calculate standard error for confidence interval
SE <- sqrt((C1 * C2 * (C1 - R) * (C2 - R)) / ((R + 1)^2 * (R + 2)))

# Calculate Confidence Interval
con_lower <- estimate_size - qnorm(0.975) * SE
con_upper <- estimate_size + qnorm(0.975) * SE
```

Results

```r
estimate_size
```

```
[1] 692.75
```

```r
con_lower
```

```
[1] 369.9785
```

```r
con_upper
```

```
[1] 1015.522
```

Conclusion

The estimated population size of Rainbow Trout in Upper Niagara Springs Pond in 2000 is approximately 693. The confidence interval indicates that we are 95% confident that the true population size lies between 370 and 1020.

References

1. Ogle, D. H. (2018). Introductory Fisheries Analyses with R. United States: CRC Press.
2. Warren, C. D., Frank, K. A. and Partridge. F. E. (2004). Regional fisheries management investigations - Magic Valley region. Completion Report, Idaho Department of Fish and Game.