Living Data Project Manuscript

Effects of Brook Trout on Juvenile Chinook Salmon Survival

Sophia Kast[1]*

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1. Biology Department, University of British Columbia, Okanagan Campus

*Corresponding Author

Abstract

Invasive species can affect the survival of indigenous species. In this project, I use data from a 2002 study looking at the effect of brook trout on the survival of juvenile Chinook salmon in the Salmon River watershed in Idaho, in the western United States. I visualize the data to see if there is a correlation between presence of brook trout and survival of juvenile salmon. The overlying purpose of this project is to learn best practices for open science workflows and understand how to create reproducible scientific research projects from start to finish.

Key-words: brook trout, Chinook salmon, salmon survival

Introduction

As the planet becomes increasingly spatially connected by humans, there are increasing conduits for other species to move out of their native ranges. This can have a variety of effects. Sometimes, novel species in a region can detrimentally affect the survival of established indigenous populations. Brook trout, a salmonid fish native to northeastern North America. Its range has artificially expanded and it is now one of the most populous non-native fish species in the western United States. It has been suspected that these trout may negatively affect native salmon populations in western watersheds. In this project, I borrow data from a 2002 study investigating juvenile Chinook salmon survival in the Salmon River watershed, where some streams have robust brook trout populations and others do not. At each site, researchers tagged juvenile salmon in the fall. The following spring, these tagged salmon were tracked at the Lower Granite Dam to determine the number of survivors (Levin et al., 2002).

The purpose of this mini-project is to demonstrate knowledge of open science practices and workflows. To do this, I will simply create 3 different plots of the data associated with the 2002 study by Levin et al. (Levin et al., 2002).

Methods

Both code and outputs are shown for the purposes of this project to demonstrate knowledge of creating code chunks and corresponding output.

First, set up the project directory:

```
if( ! dir.exists("data") ){ dir.create("data") }
```

Load packages using `groundhog`. The package `grateful` is used to cite packages, but cannot be loaded using `groundhog` due to its storage location on GitHub. First, it needs to be installed using the `install_github` function in the `remotes` package.

```
library('groundhog')
groundhog.library(c('tidyverse', 'tinytex', 'remotes'), '2022-09-01')
remotes::install_github('Pakillo/grateful')
library('grateful')
```

Run the function

```
get_pkgs_info()
```

This creates the package bibliography. The output is not shown here as it is not necessary for the purposes of this manuscript.

Read the data stored at the following url: https://whitlockschluter3e.zoology.ubc.ca/Data/chapter12/chap12e4ChinookWithBrookTrout.csv.

```
salmon_raw <- readr::read_csv('https://whitlockschluter3e.zoology.ubc.ca/Data/chapter12/chap12e4Chinook
```

Tidy the data by changing the column names. Add a column to indicate site location number. Do not conduct calculations. The proportion of salmon surviving at Lower Granite Dam is already present in the raw table.

```
salmon <- mutate(salmon_raw,
                 troutTreatment = stringr::str_to_title(troutTreatment), # capitalize
                 site = row_number()) %>% # add column 'site' to dataframe
  rename(brook_trout_presence = troutTreatment, # rename the columns
         salmon_released = nReleased,
         surviving_salmon = nSurvivors,
         proportion_survived = proportionSurvived) %>%
  relocate(site, .before = brook_trout_presence) # move 'site' to first column
```

Write the file to a .csv to reference when creating plots.

```
write.csv(salmon, file = 'data/salmon_clean.csv')
```

Results

Visualize the data in 3 separate plots to gain experience creating plots in RStudio.

First, create a scatterplot showing the number of surviving salmon based on the number of released salmon.

```
plot(salmon$surviving_salmon~salmon$salmon_released,
     xlab = '# of Salmon Released', # x axis label
     ylab = '# of Salmon Surviving', # y axis label
     col = "black") # point color is black
```

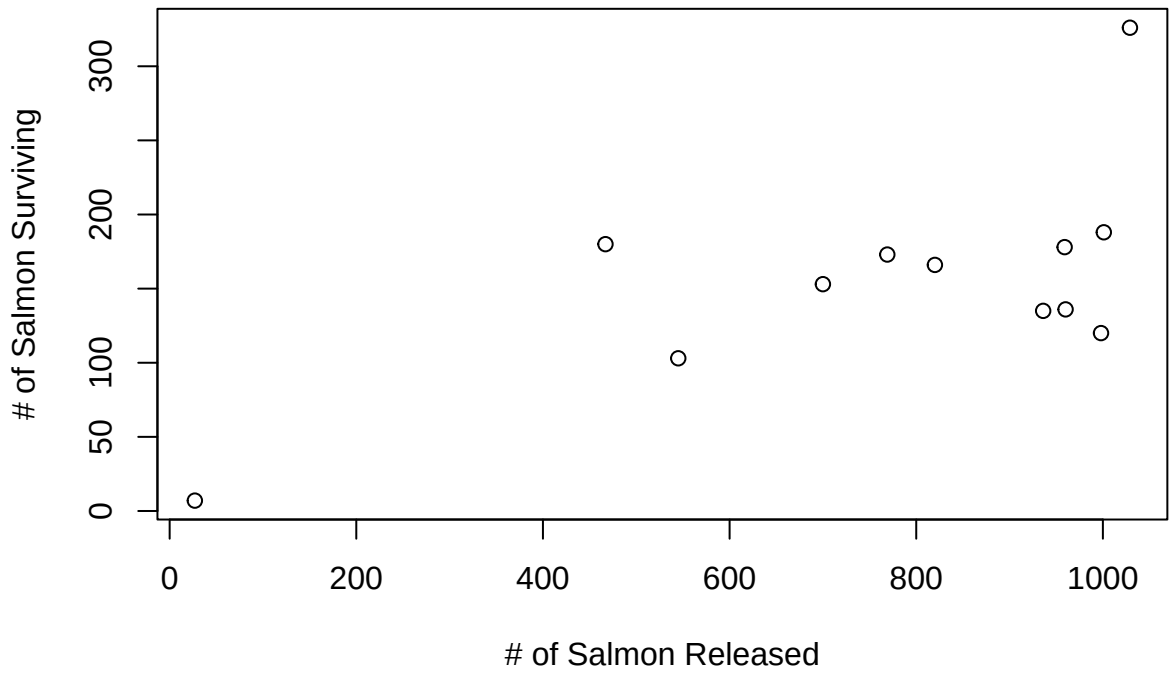

Figure 1: Salmon Survival at Lower Granite Dam

Next, create a strip chart showing the proportion of surviving salmon for each brook trout treatment (presence or absence).

```
salmon %>%
  ggplot(aes(x = brook_trout_presence, y = proportion_survived)) +
  geom_jitter(colour = "black", size = 3, shape = 1, width = 0.1) + # black points
  xlab("Brook Trout Population") + # x axis label
  ylab("Proportion of surviving salmon") + # y axis label
  ylim(0, 0.5) + # set scale limits
  theme_bw() # use a black and white theme
```

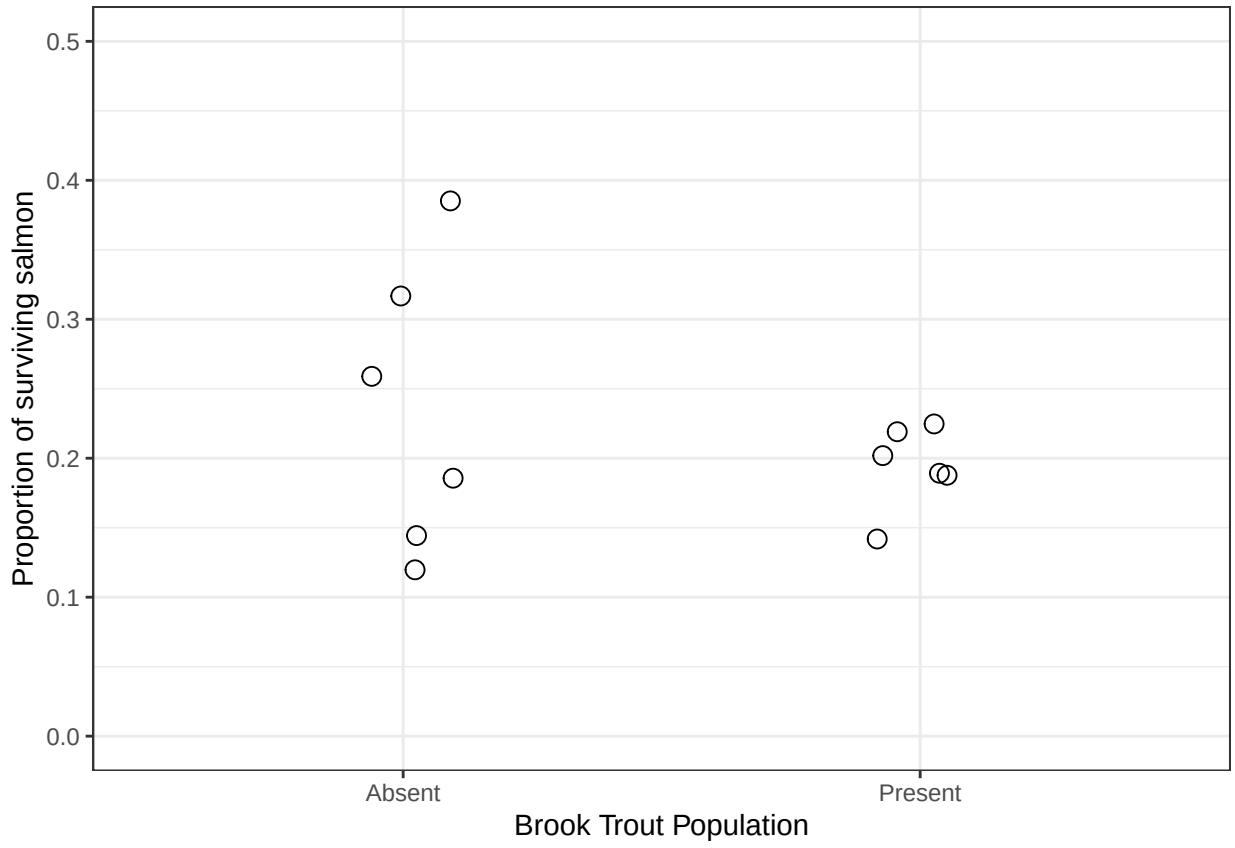

Figure 2: Salmon survival based on presence of brook trout, showed as a strip chart

Finally, create a violin chart to represent the same data as in the stripchart, but with a different visual style.

```
surviving_salmon.violin <- salmon %>% # set object
  ggplot(aes(x = brook_trout_presence, y = proportion_survived)) + # select data
  geom_violin() + # plot type is violin
  xlab("Brook Trout Population") + # x axis label
  ylab("Proportion of Surviving Salmon") + # y axis label
  theme_bw() # use a black and white theme

surviving_salmon.violin.points <- surviving_salmon.violin + # set object
  geom_jitter(colour = "black", size = 3, shape = 1, width = 0.1) # black points

surviving_salmon.violin.points # view violin plot
```

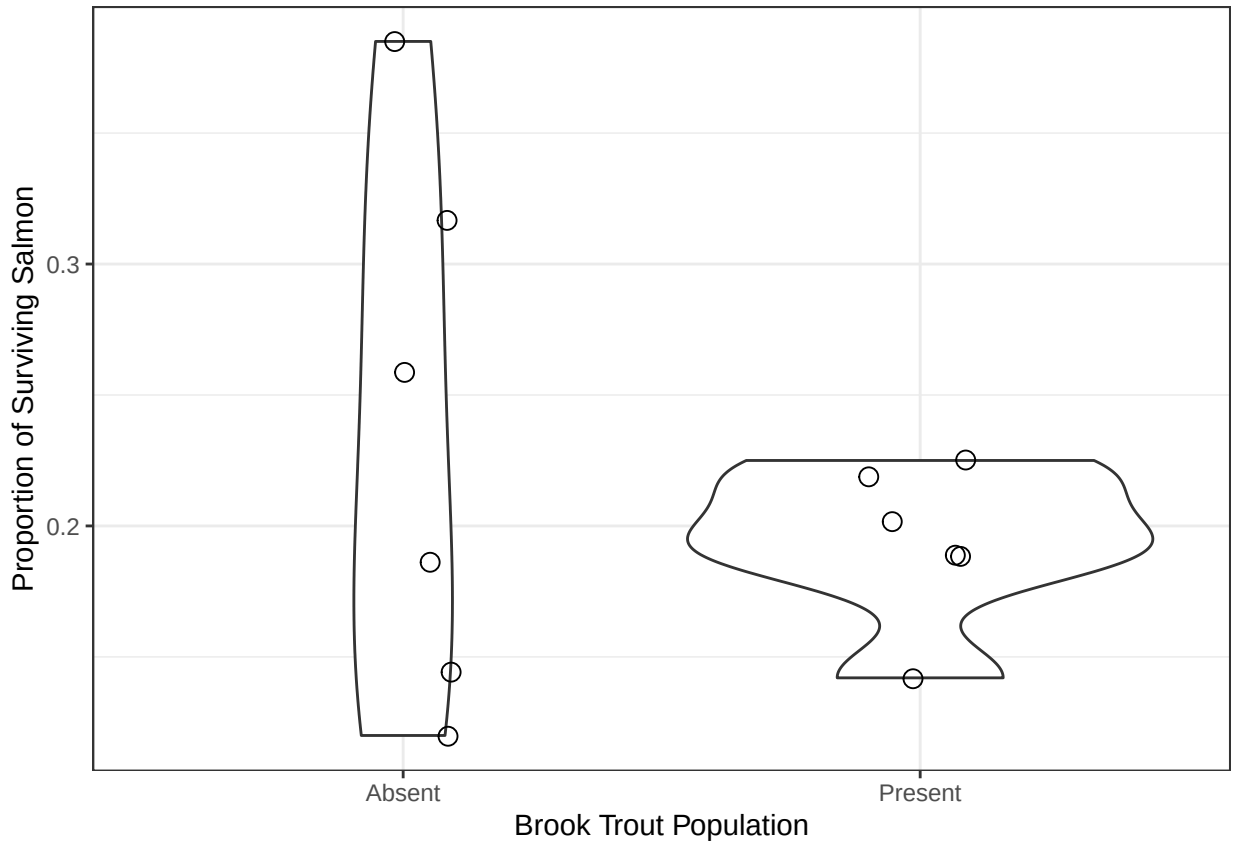

Figure 3: Salmon survival based on presence of brook trout, showed as a violin chart

Finally, run the following function to cite the packages in the manuscript.

```
cite_packages(output = 'paragraph')
```

We used R version 4.2.1 (R Core Team, 2022) and the following R packages: grateful v. 0.1.11 (Rodríguez-Sánchez et al., 2022), groundhog v. 2.0.1 (Simonsohn & Gruson, 2022), knitr v. 1.40 (Xie, 2014, 2015, 2022), remotes v. 2.4.2 (Csárdi et al., 2021), rmarkdown v. 2.16 (Allaire et al., 2022; Xie et al., 2018, 2020), tidyverse v. 1.3.2 (Wickham et al., 2019).

Discussion

The plots of this data show that brook trout may be affecting the survival of juvenile Chinook salmon as they make their way from spawning grounds to the Lower Granite Dam. Results from 3 of the sites where brook trout were absent shower much higher survival rates of salmon. However, 3 other sites without brook trout showed no difference in survival rate from those with brook trout. This could indicate that there were other issues impacting brook trout survival. These factors could include increased water temperatures, pressure from sport fishing, other predation pressures, water pollution, and others. Further research is necessary to understand the exact effects that brook trout may have on Chinook salmon survival in the Salmon River watershed.

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