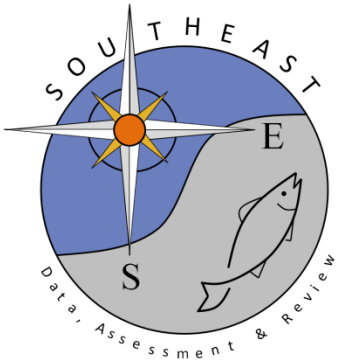
Length-Frequency Snapshot of Yellowtail Snapper from Image Analysis in Puerto Rico

Derek Soto, Alejandro Carrera Montalvo, Todd Gedamke

SEDAR84-DW-13

22 February 2024



Please cite this document as:

Soto, Derek; Carrera, Alejandro; Gedamke, Todd. 2024. Length-Frequency Snapshot of Yellowtail Snapper from Image Analysis in Puerto Rico. SEDAR84-WP-13. SEDAR, North Charleston, SC. 9 pp.

`

Introduction

The information contained in this report was collected as part of two research projects. The first project conducted by MER Consultants began in 2017 and was titled Port Sampling Validation Project whereby samplers were deployed all over Puerto Rico to estimate the total commercial landings of all species. As part of this project, images were collected to validate species identification, and a system was developed to utilize advances in computer vision and machine learning/artificial intelligence. The first prototypes of this system (Figure 1) automated the process so that when a stable weight was achieved, a photograph was taken of the individual fish. Calibration of the system was achieved by $1cm^2$ squares overlayed on the boards to be able to convert pixels to a digital length measurement. Full automation of this process, including automatic identification and automatic length measurement is in the final stages of development. The images and the annotations which were used to generate the length data presented in this report were individually curated and digitally measured by trained annotators. These annotations and length measurements are being utilized for training and validating the fully automated technique.

During the Port Sampling Project which was conducted from 2017-2019, over 20,000 images were captured, including the 1812 yellowtail snapper that are included in this report. While the survey was successful in capturing landings for most species, the landings estimated by the project were not consistent with reported landings for deepwater snapper and yellowtail snapper (Gedamke et al. 2020). These fisheries land at night and are difficult to capture in a traditional port sampling program. As such, NOAA contracted additional work through MER Consultants, in partnership with Oceanology and the University of Puerto Rico. One graduate student was funded to conduct a further evaluation on patterns of fishing and determine spatial and temporal patterns of fishing effort so that an efficient survey design could be developed. An additional objective of this thesis was to utilize the rapid sampling system and digital image analysis used in the port sampling design to obtain a snapshot of current length structure of landings. During 2023, 672 photographs were collected from 14 locations (Figure 2) to attempt to obtain a representative snapshot. A small subset of these individuals were manually measured to validate the computer vision length estimation. Unfortunately, the student left the project and none of their work were deemed suitable for use in these analyses. Luckily, we were able to revisit the digital image repository and data were reprocessed to ensure validity. We would like to highlight the massive benefit of having a digital image catalog where images can be revisited if necessary.

Methodology

Fresh yellowtail were weighed by placing a green screen board placed on the rapid sampling scale. The scale syncs to a tablet running the MER Consultants Port Sampling Application via a Bluetooth link. Once weight stabilized, a photograph of the catch was taken. The weight of the fish is automatically embedded in the image name. Images were then uploaded to a cloud repository. A total of 2482 yellowtail were digitally measured; 1812 fish during the 2017 Census and 682 during the 2023 follow-up. Additionally, fork lengths of 72 samples were measured by hand for validation of digital length measurements.

Digital length estimations were obtained by marking standard length, fork length, and total length on yellowtail photographs using MER Consultants in-house annotator. Calibrations

`

were obtained by measuring the black and white 1cm^2 calibration squares. Length and calibration annotations were exported in JSON format and imported into R for processing and visualization. Annotations were converted from coordinates into length (pixels) using the Pythagorean theorem and then converted into digital length measurements (mm) using the length of the calibration squares as a conversion factor.

Digital length measurements were validated by comparing these measurements of manually measured fish (FL). This relationship were described using a linear model fitted to a zero y-intercept (y~x+0). This model fit the data well therefore a correction of digital length estimates was deemed unwarranted.

Results and Discussion

Figures 3-5 are plots of fork length frequency and Figures 6-8 are plots of total length frequency obtained through digital image analysis. For each metric, data were presented collectively, by individual subsets, and in overlaid density plots. Figures 9-11 display the relationships between fork, total, and standard lengths, respectively. Figure 12 is a length-length validation plot showing the relationship between manual and digital fork length measurements in 72 yellowtail. Figure 13 shows residuals for this validation plot. Figure 14 shows the adjusted validation plot with a corrected linear equation for converting from digital to manual length measurements

Literature Cited

Gedamke, T., Hoenig, J.M., Carrera, A., Omori, K., Gross, J., Lastra, L., Young, J.Y, Soto, N., Hernandez, J. & Hanke, M. (2020). Puerto Rico Port Samling and Catch Validation Project: Final Report. MER Consultants, LLC

Figure 1 Rapid sampling system prototype

`

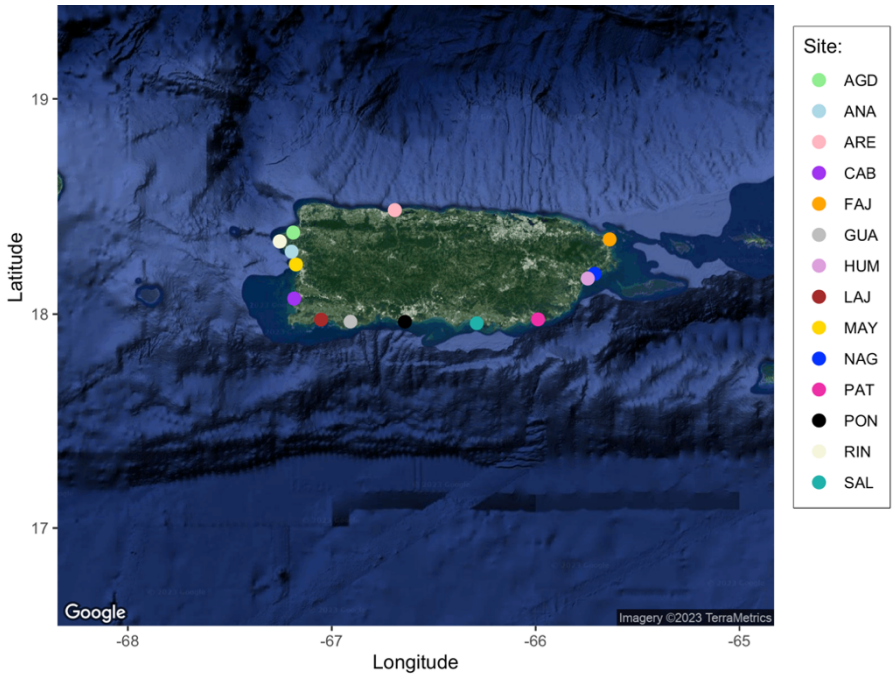


Figure 2 Map of 2023 Study Sites

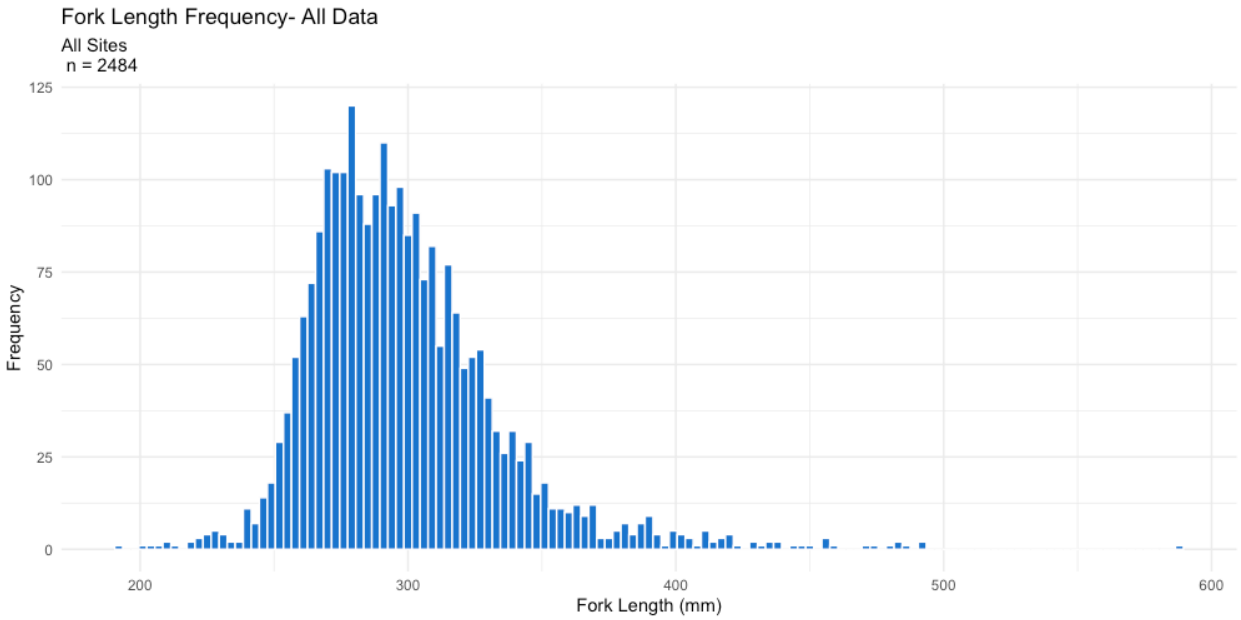


Figure 3 Digitally measured fork length frequency histogram of yellowtail snapper for 2023 and 2017 datasets.

`

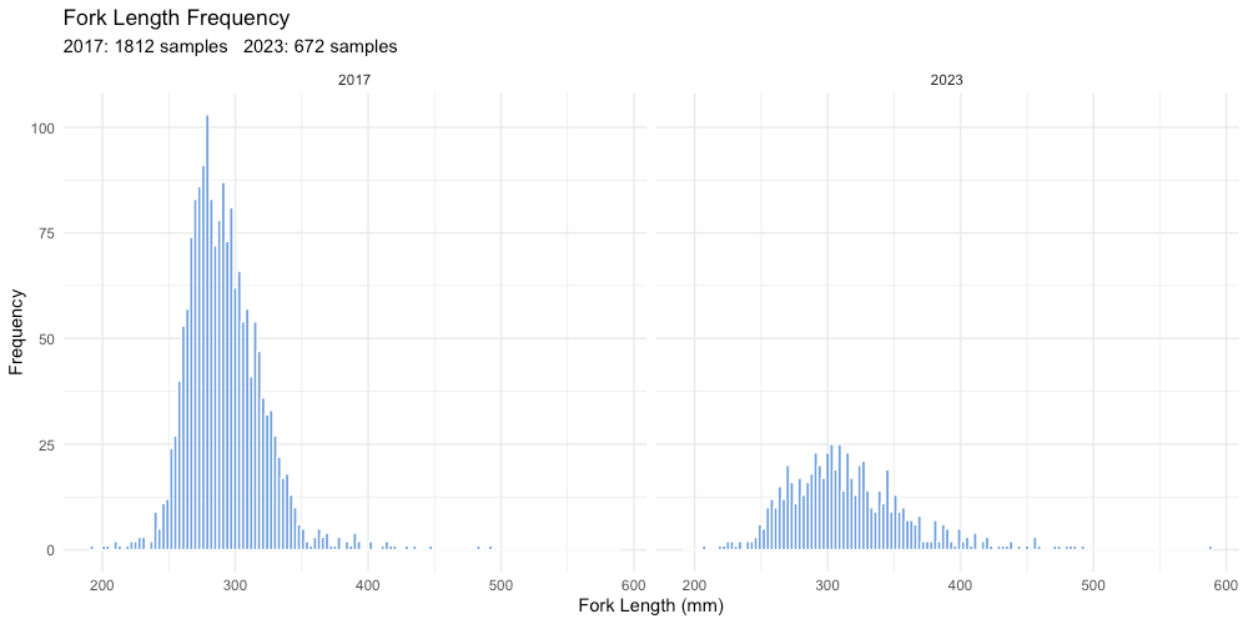


Figure 4 Digitally measured fork length frequency histogram of yellowtail snapper by subsets.

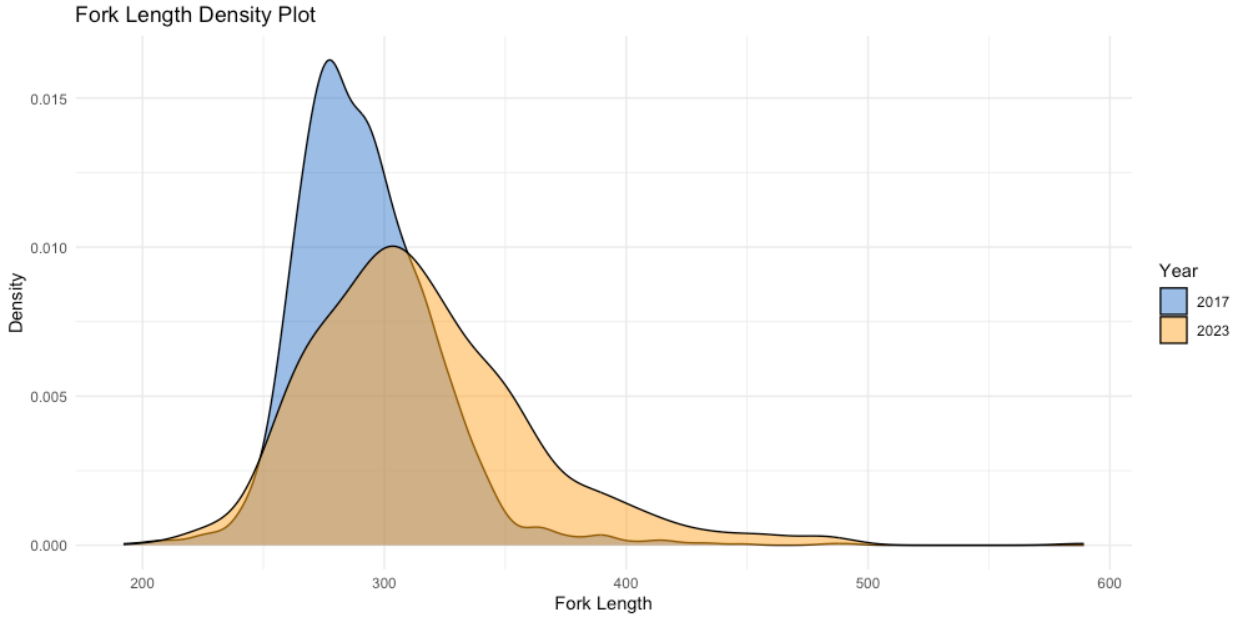


Figure 5 Density plot of yellowtail snapper fork lengths by subsets.

`

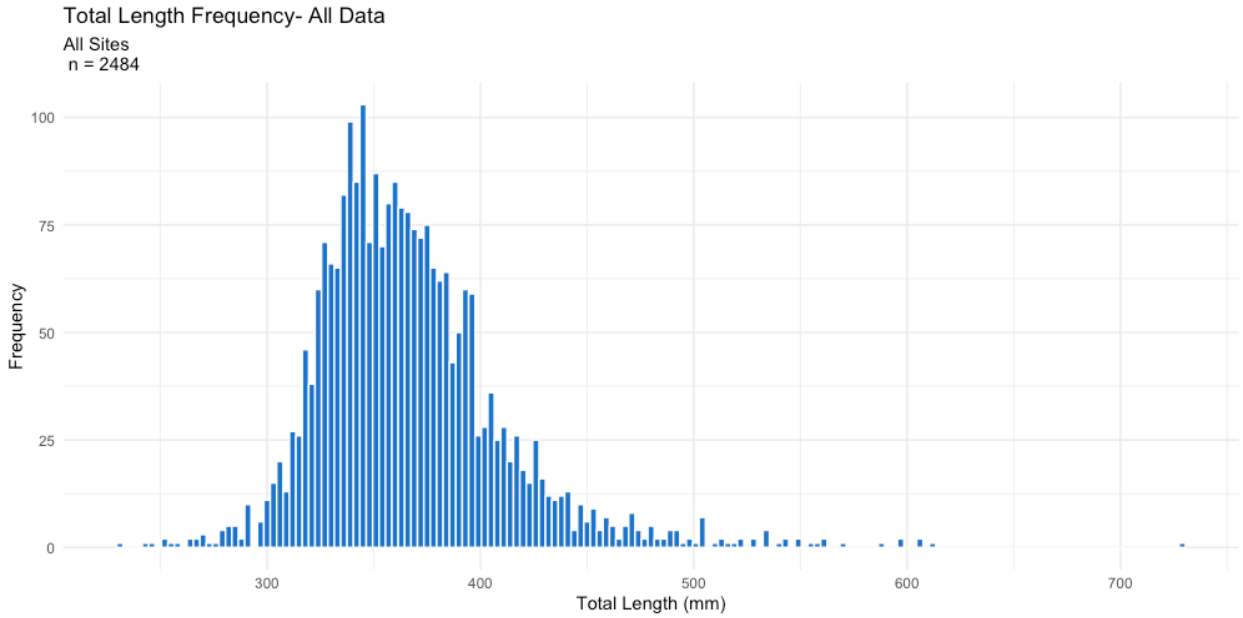


Figure 6 Digitally measured total length frequency histogram of yellowtail snapper for 2023 and 2017 datasets.

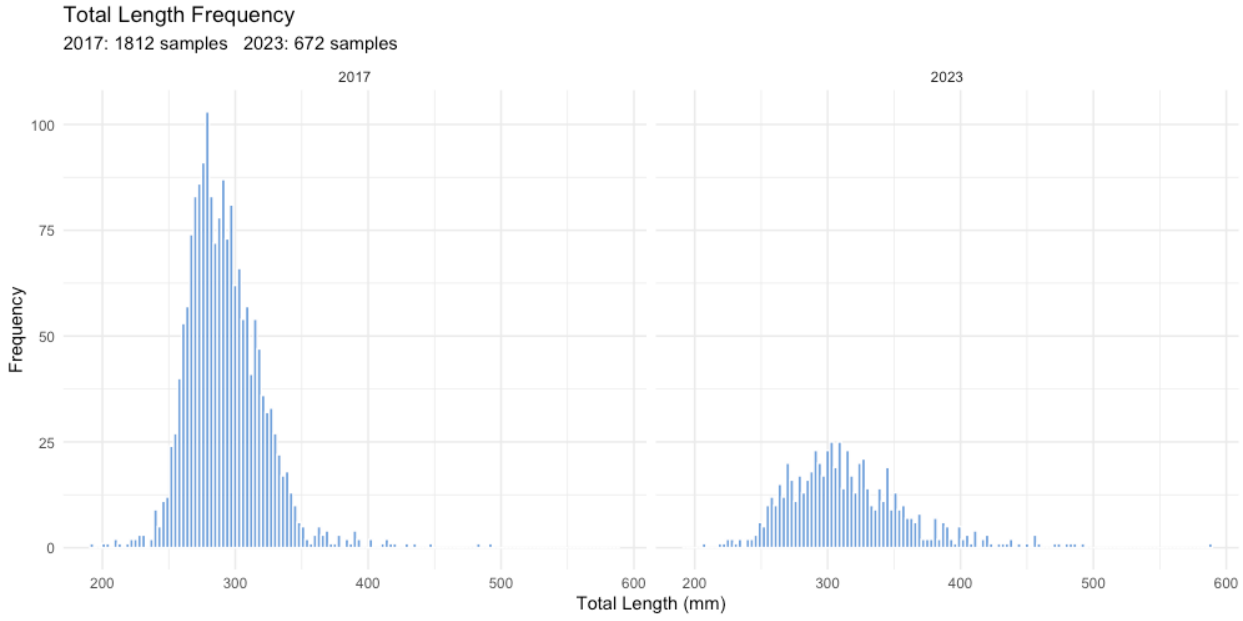


Figure 7 Digitally measured total length frequency histogram of yellowtail snapper by subsets.

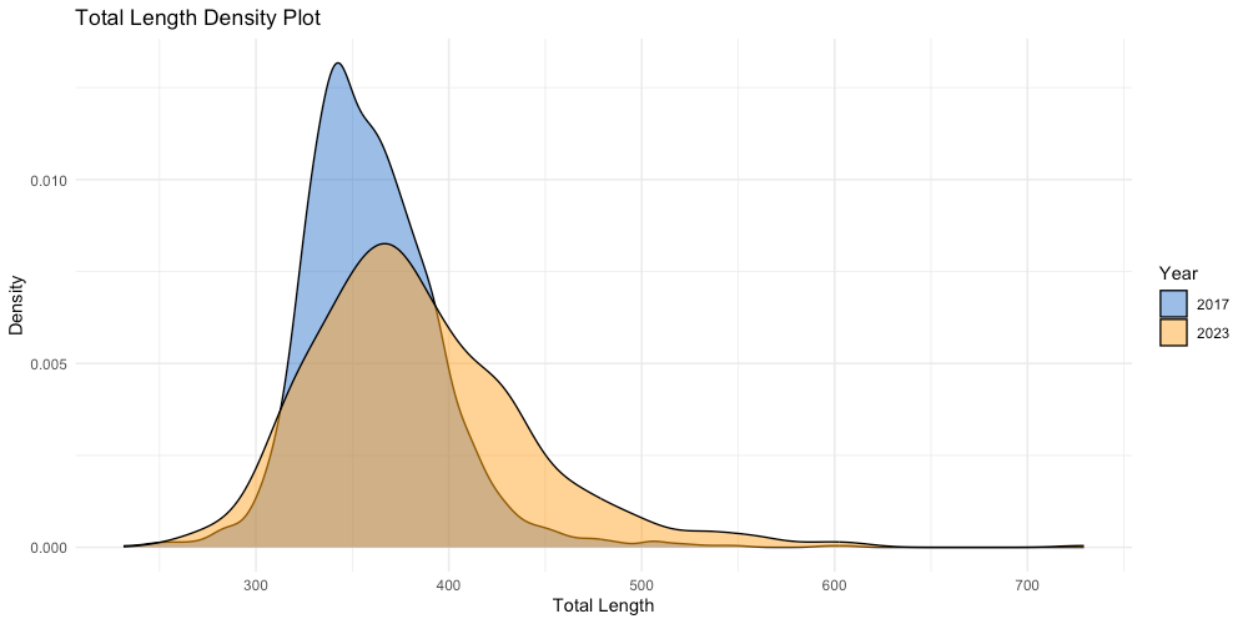


Figure 8 Density plot of yellowtail snapper total lengths of by subsets.

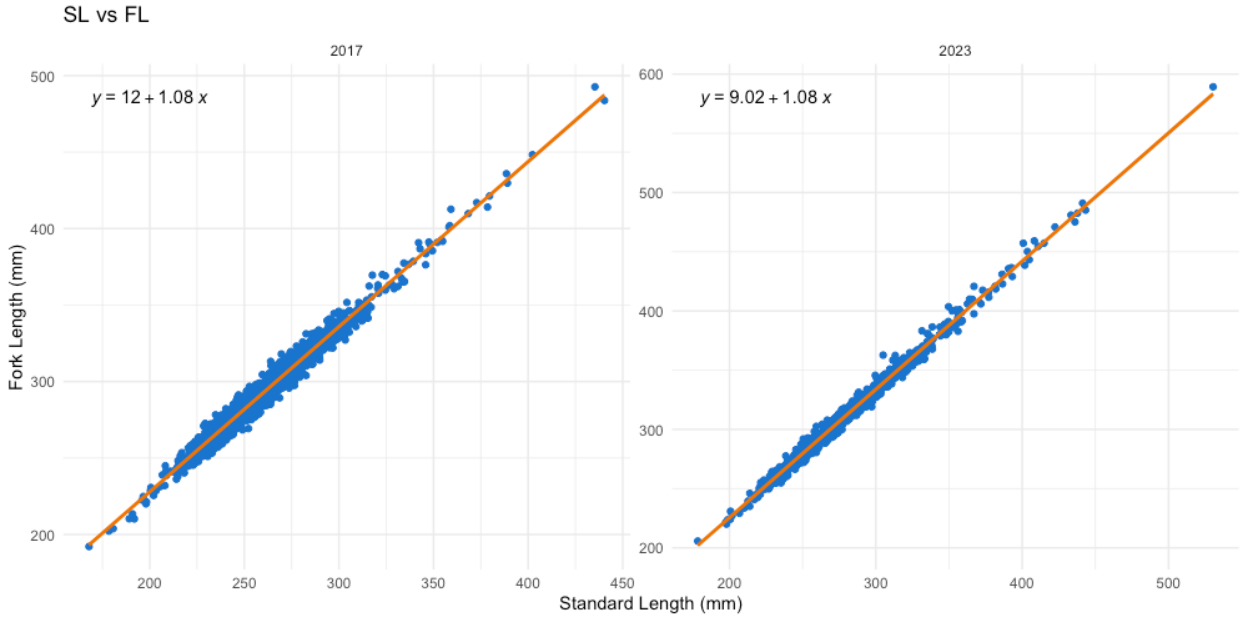


Figure 9 Standard length to fork length conversion of yellowtail snapper by subsets

`

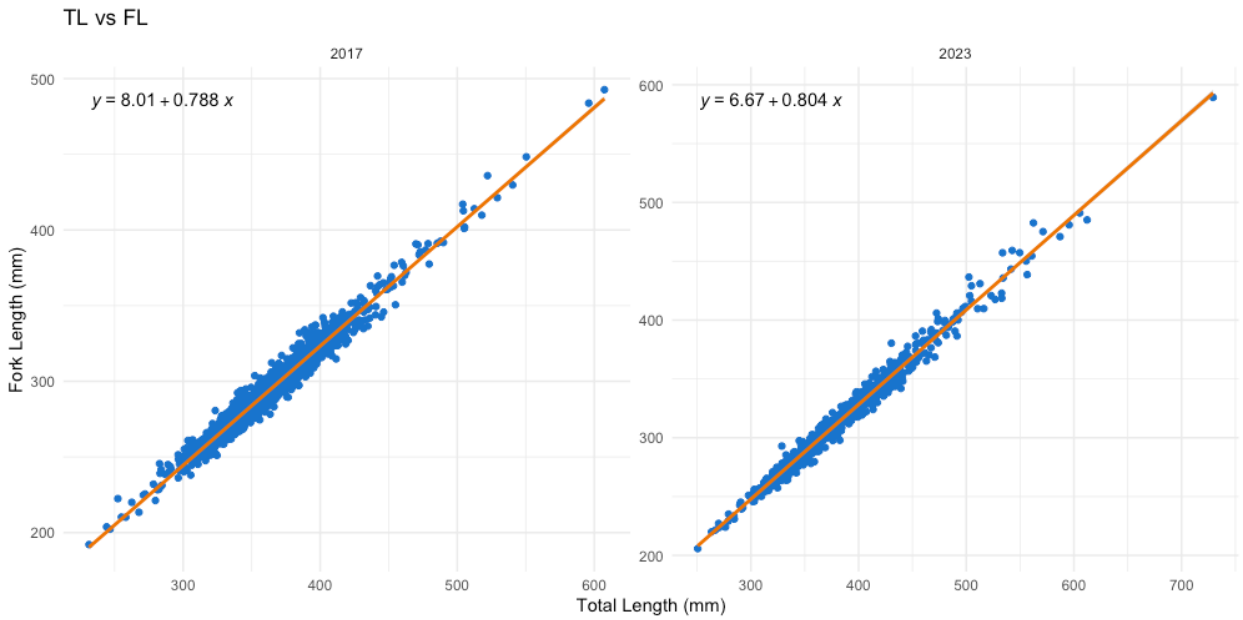


Figure 10 Total Length to Fork Length Conversion of yellowtail snapper by subsets

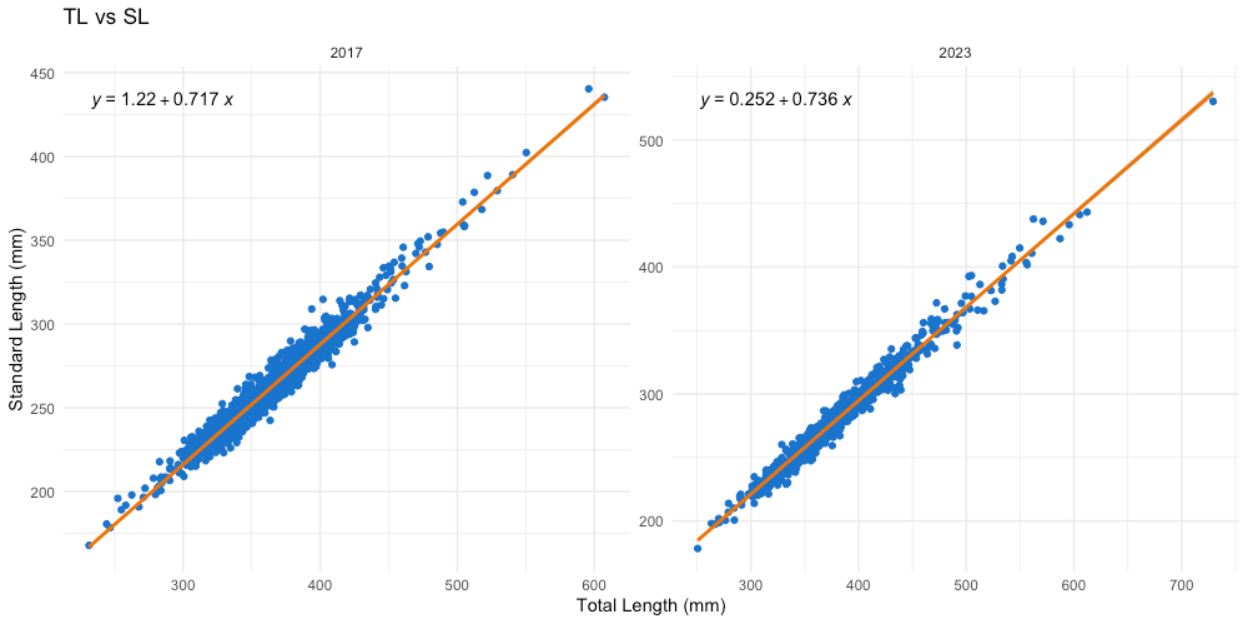


Figure 11 Total length to standard length conversion of yellowtail snapper by subsets.

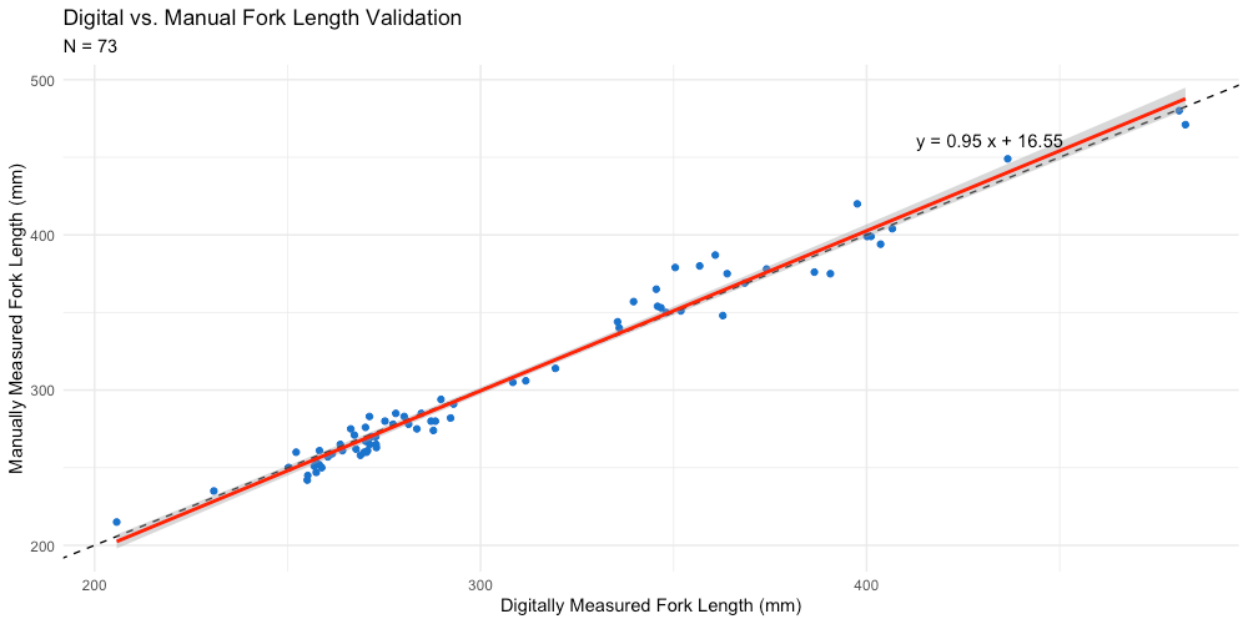


Figure 12 Preliminary validation of digital length estimation for yellowtail snapper.

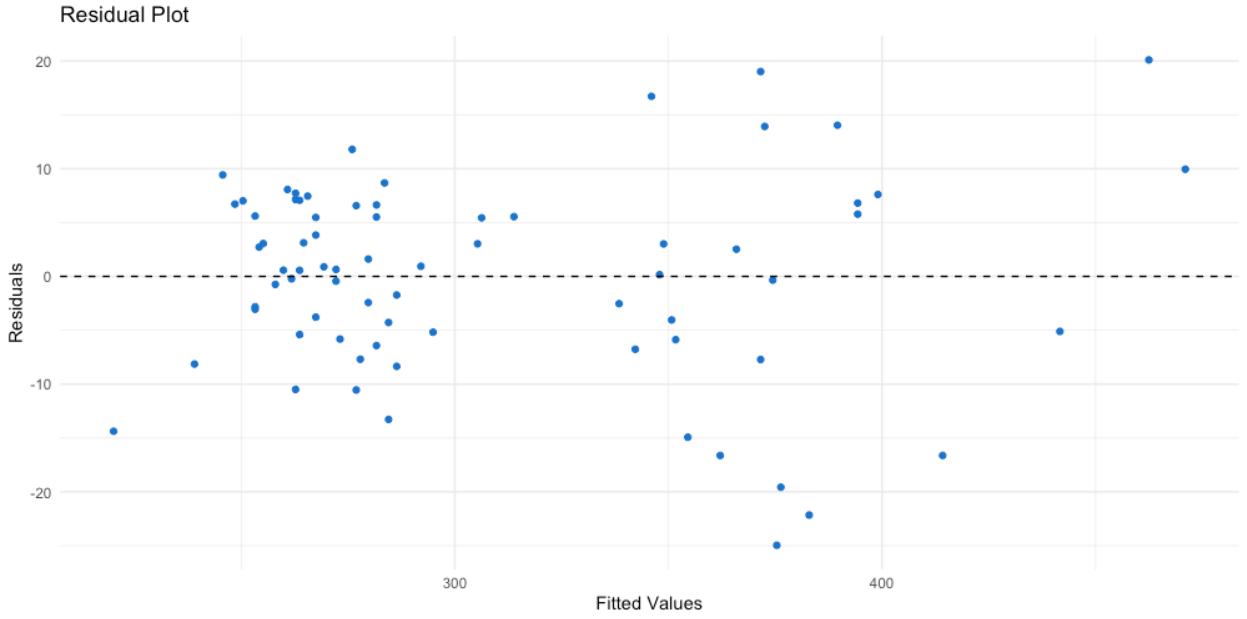


Figure 13 Residuals plot of digital length estimation validation for yellowtail snapper.

`

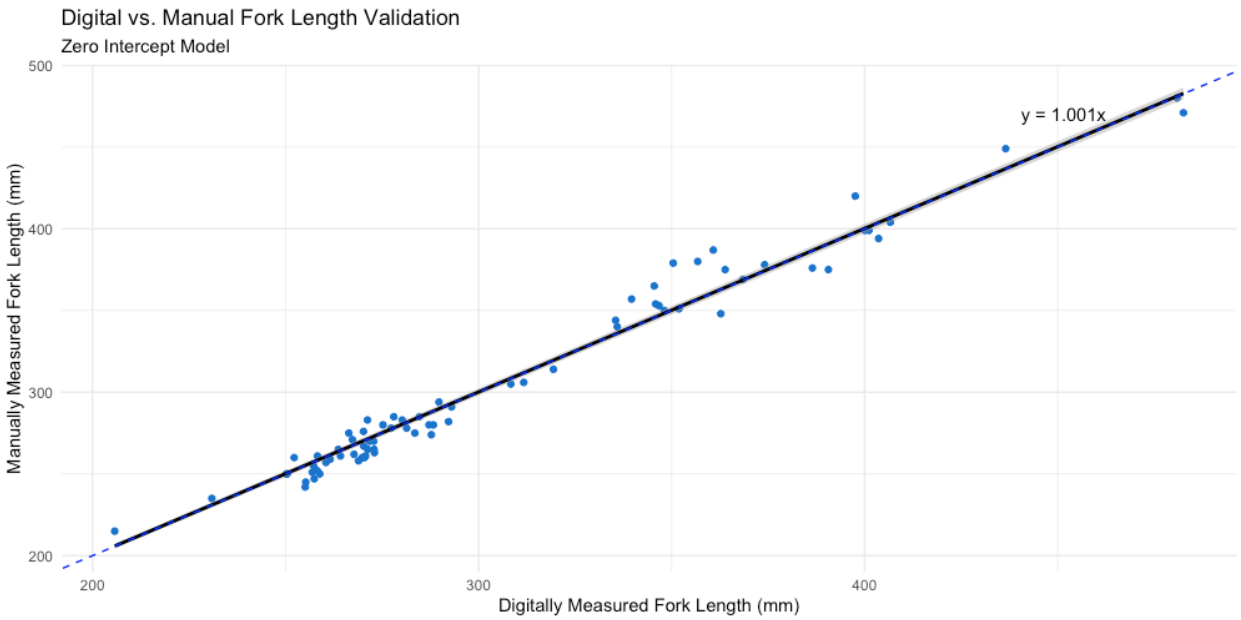


Figure 14 Zero-intercept corrected validation of digital length estimation for yellowtail snapper.