

Untitled

Title page

Title: Length - weight relationship for the invasive lionfish (*Pterois volitans*) in Playa del Carmen, Mexico

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Running title: Length - weight relationship of *Pterois volitans*

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Title**Abstract**

300 words

Key words

lionfish, biometry, length-weight relationship, Mexico

Resumen**Palabras clave**

pez león, biometría, relación longitud-peso, México

Introduction

Materials and Methods

```
suppressPackageStartupMessages({  
  library(RColorBrewer)  
  library(colorRamps)  
  library(stargazer)  
  library(sandwich)  
  library(lmtest)  
  library(broom)  
  library(tidyverse)  
})  
  
fish <- read_csv("./lionfish_data.csv", col_types = cols()) %>%  
  group_by(Id, Site, Location, Latitude, Longitude, Depth_m) %>%  
  summarize(Length = 10*mean(TotalLength_cm),  
            Weight = mean(TotalWeigth_gr),  
            Stomach = mean(StomachLength_cm)) %>%  
  ungroup()
```

Results

```
fish %>%  
  select(Length, Weight, Stomach, Depth_m) %>%  
  as.data.frame() %>%  
  stargazer(header = F, type = "html", digits = 2)
```

Statistic

N

Mean

St. Dev.

Min

Max

Length

109

140.22

62.41

34

310

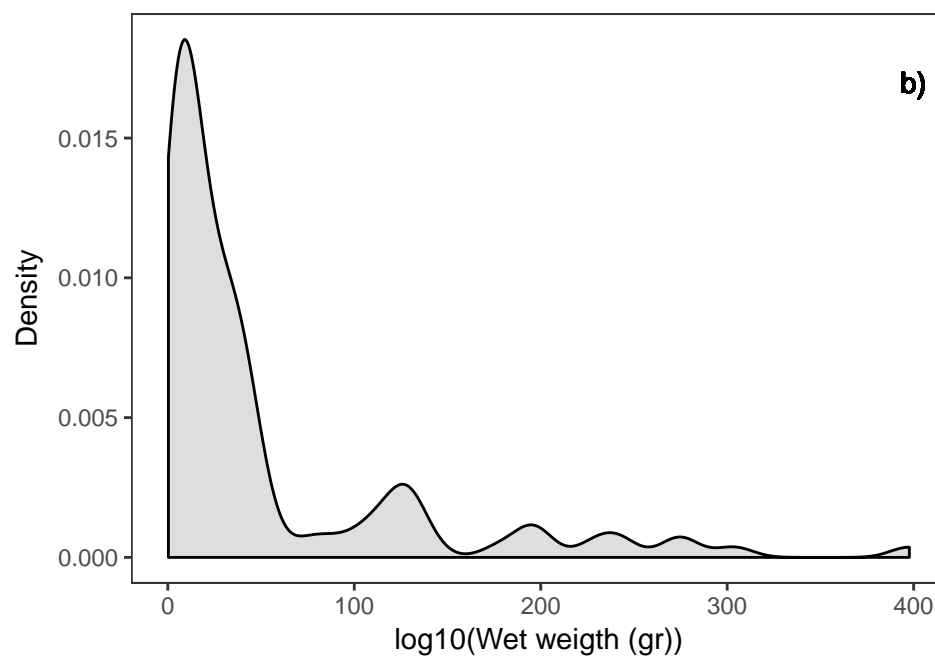
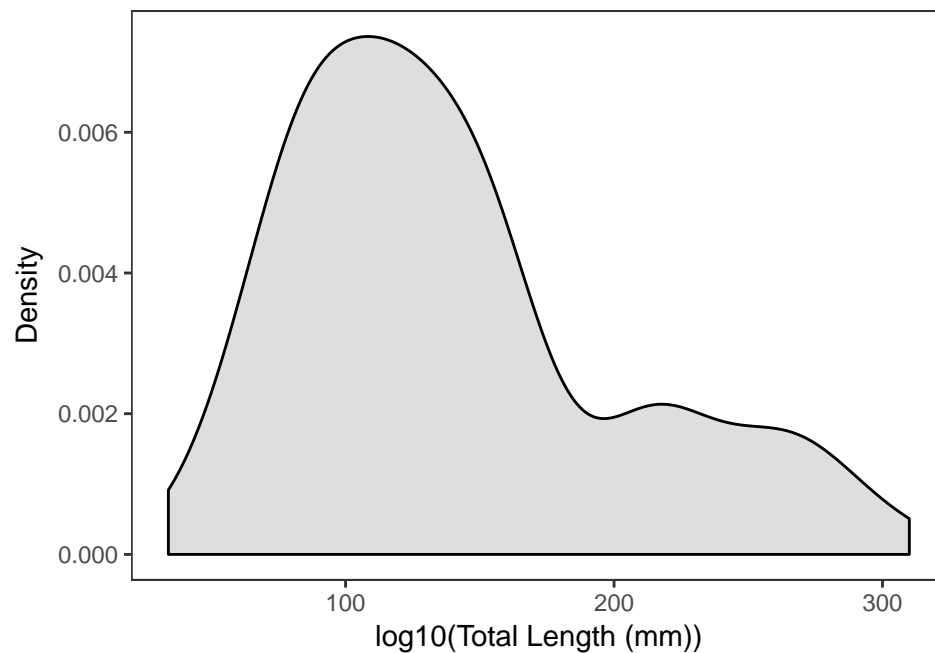
Weight

109

52.56

76.58
0.30
397.70
Stomach
109
4.01
2.08
0.90
13.20
Depth_m
109
18.60
6.31
5.70
38.10

```
length_hist <- ggplot(data = fish, mapping = aes(x = Length)) +  
  geom_density(fill = "gray", alpha = 0.5) +  
  theme_bw() +  
  ggExtra::removeGrid() +  
  labs(x = "log10(Total Length (mm))", y = "Density") +  
  geom_text(label = "a", x = 310, y = 0.07)  
  
weight_hist <- ggplot(data = fish, mapping = aes(x = Weight)) +  
  geom_density(fill = "gray", alpha = 0.5) +  
  theme_bw() +  
  ggExtra::removeGrid() +  
  labs(x = "log10(Wet weight (gr))", y = "Density") +  
  geom_text(label = "b", x = 400, y = 0.017)  
  
gridExtra::grid.arrange(length_hist, weight_hist)
```



```
model <- lm(log(Weight) ~ log(Length), data = fish)
```

```
TidyModel <- model%>%
  lmtest::coeftest(vcov = sandwich::vcovHC(., type = "HC1")) %>%
  broom::tidy()
```

```
robust_se <- TidyModel$std.error %>%
  set_names(TidyModel$term)
```

```
wald_results <- waldtest(model, vcov = vcovHC(model, type = "HC1"))
```

```
f_string <- c(paste0("F Statistic (df = 1, ", dim(fish)[1]-2, ")"), formatC(wald_results$F[2], digits = 2
```

```
stargazer(model,
  header = F,
  se = list(robust_se),
  type = "html",
  t.auto = T,
  p.auto = T,
  intercept.bottom = F,
  single.row = T,
  report = "vcs*",
  omit.stat = "rsq",
  add.lines = list(f_string))
```

Dependent variable:

log(Weight)

Constant

-12.651 (0.191)***

log(Length)

3.235 (0.039)***

F Statistic (df = 1, 107)

6928.67

Observations

109

Adjusted R2

0.976

Residual Std. Error

0.222 (df = 107)

F Statistic

4,458.126*** (df = 1; 107)

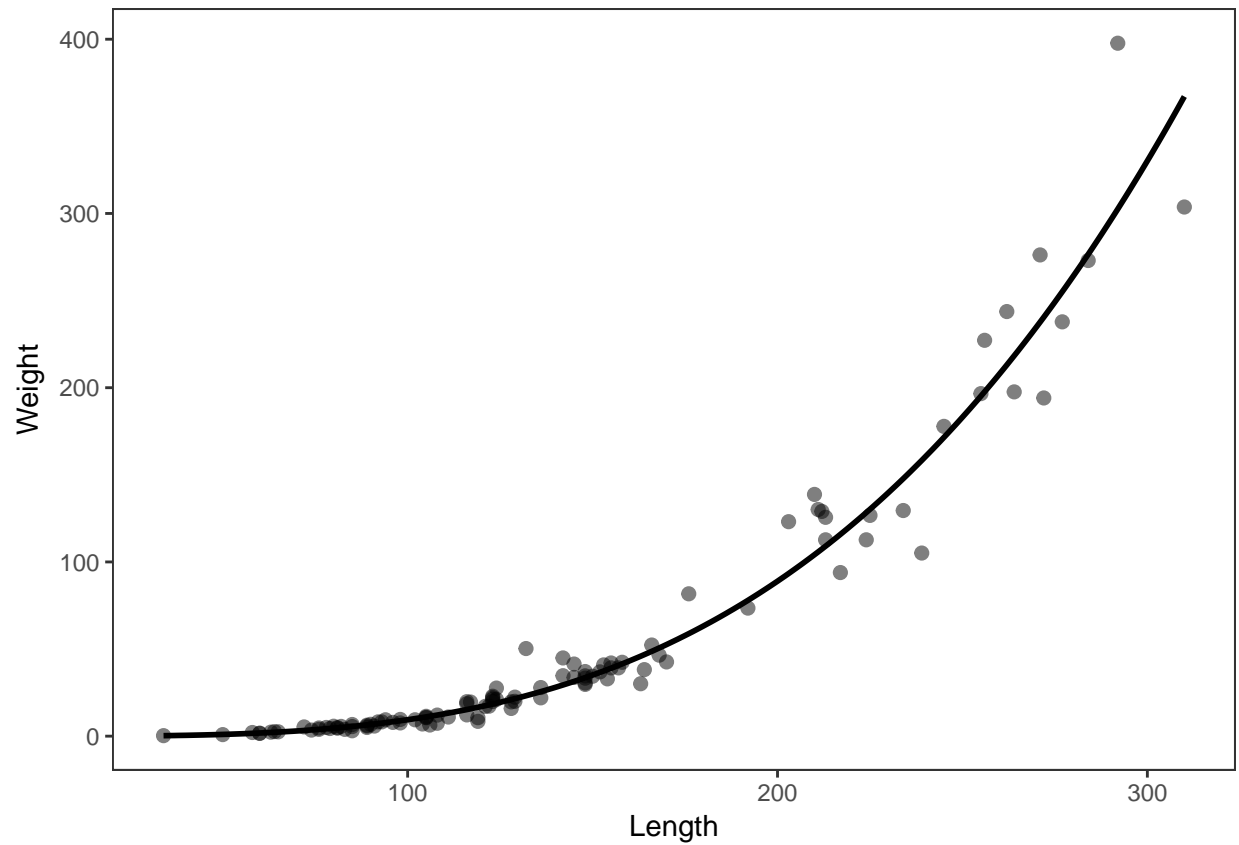
Note:

$p < 0.1$; $p < 0.05$; $p < 0.01$

```
a <- coefficients(model)[[1]]
b <- coefficients(model)[[2]]
```

```
predicted <- data.frame(Length = seq(min(fish$Length), max(fish$Length), by = 1)) %>%
  mutate(Weight = exp((b*log(Length)) + a))
```

```
ggplot(data = fish, mapping = aes(x = Length, y = Weight)) +
  geom_line(data = predicted, mapping = aes(x = Length, y = Weight), size = 1) +
  geom_point(size = 2, alpha = 0.5) +
  theme_bw() +
  ggExtra::removeGrid()
```



```
review <- read_csv("biometric_review.csv", col_types = cols())
stargazer(review, summary = F, header = F, type = "html", rownames = F)
```

Study
Study site
N
a
b
CI95a
CI95b
r2
Method
Formula
uL
uW
tL
Gender
Spear

minD
 maxD
 Years
 Aguilar-Perera
 Quijano-Puerto, 2016
 Arrecife Alacranes, Mexico
 472
 -2.24
 3.3
 -2.32–2.15
 3.24–3.36
 0.95
 log transformed and ordinary least squares
 $Y = a + bX$
 mm
 g
 total
 Both
 Yes
 5
 20
 Aguilar-Perera
 Quijano-Puerto, 2016
 Arrecife Alacranes, Mexico
 67
 -5.93
 3.47
 -5.15–3.94
 2.64–3.14
 0.95
 log transformed and ordinary least squares
 $Y = a + bX$
 mm
 g
 total
 F

Yes

5

20

Aguilar-Perera

Quijano-Puerto, 2016

Arrecife Alacranes, Mexico

59

-5.38

3.23

-6.41–5.48

2.64-3.67

0.95

log transformed and ordinary least squares

$Y = a + bX$

mm

g

total

M

Yes

5

20

Sandel et al., 2015

Southern Caribbean Coast of Costa Rica

458

0.0235

2.81

NA

Non-linear least squares

$W = aLb$

cm

g

total

Both

Yes*

NA

NA

2011
Chin et al 2016
Discovery Bay, Jamaica
419
-4.56
2.85
0.8715
 $W = aLb$
mm
g
total
Both
Yes
18.3
18.3
2012 - 2014
Brbour et al 2011
North Carolina
774
2.89e-05
2.89
NA
maximum likelihood of the normal distribution
 $W = aLb$
mm
g
total
Both
Yes*
27
45
2004 - 2009
de Leon et al., 2013
Bonaire
1450
2.285e-05

2.89
0.96
 $W = aLb$
mm
g
total
Both
NA
NA
Fishbase
NA
0.0115
3.09
0.00441-0.02989
2.87-3.31
NA
based on LWR estimates for this (Sub)family-body shape
 $W = aLb$
NA
NA

Discussion and Conclusions

Aknowledgements

References

Raw data