Data Management and Transformation

EVR 628- Intro to Environmental Data Science

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Exercise 1: Reading and transforming data

Your boss asked you what sounds like a simple query:

> How much money have tuna purse seiners made since 2000 when fishing for bigeye tuna (*Thunnus obesus*) in the Eastern Pacific Ocean?

Let's make some assumptions that will help us answer this question:

1. We will interpret "making money" as revenue, not profits
2. The market price of tuna since 2000 has remained relatively stable, at around US$2/Kg (See Sibert et al. (2012))
3. We will focus on tuna production in the Eastern Pacific Ocean as reported by the IATTC

Part A) Obtaining data from the wild

How to find the data:

1. Go to iattc.org
2. In the top menu, **hover** over `DATA`
3. Click on “Public domain”
4. You will be taken to a page titled “Public domain data for download”
5. We will use “EPO total estimated catch by year, flag, gear, species”
6. Click on `CatchByFlagGear.zip` to the right of the table to prompt a download
7. Save the zip file to inside your EVR628 project at: `data/raw/`[1]
8. Using your finder / explorer, navigate to `EVR628/data/raw/` and unzip the `CatchByFlagGear.zip` file[2]
9. You will get a new folder called `CatchByFlagGear`
10. Read the PDF file enclosed, which contains the documentation

Part B) Reading data

0. **Put your post-it up**
1. Start a new script called `tuna_analysis` and save it to your `scripts/03_analysis` folder
2. Add a comment header and outline, and load the `tidyverse` package at the top of your script
3. Use the `read_csv()` function to load the new data and assign it to an object called `tuna_data`
4. What are the existing column names?[3]
5. **Remove your post-it when you are done**

```r
# Load packages
library(tidyverse)
library(janitor)

# Load the data
tuna_data <- read_csv("data/raw/CatchByFlagGear/CatchByFlagGear1918-2023.csv")
```

```
Rows: 13595 Columns: 5
-- Column specification --------------------------------------------------------
Delimiter: ","
```

[1]If your web browser didn’t allow you to specify the download folder, your file is likely in the “Downloads” folder. Navigate there and copy it to the `data/raw/` folder.
[2]Windows users: You might have to click a button called “Extract” in the top of your explorer window.
[3]Hint: use the `colnames()` function

```
chr (3): BanderaFlag, ArteGear, EspeciesSpecies
dbl (2): AnoYear, t

i Use `spec()` to retrieve the full column specification for this data.
i Specify the column types or set `show_col_types = FALSE` to quiet this message.
```

```r
# Check colnames after cleaning names
colnames(tuna_data)
```

```
[1] "AnoYear"         "BanderaFlag"     "ArteGear"        "EspeciesSpecies"
[5] "t"
```

Part C) Renaming columns with `clean_names()` and `rename()`

0. **Put your post-it up**
1. In your console, install the `janitor` package using `install.packages("janitor")`
2. Load `janitor` at the top of your script, and then read the documentation for the `clean_names()` function
3. Modify your code for the `tuna_data` object so that you pipe into `clean_names()` after reading the data
4. What are the new column names?
5. Extend the pipeline above so that we can use the `rename()` function. Rename the columns so that we only retain the English portion of the name. Let's also rename `t` as `catch`
6. **Remove your post-it when you are done**

```r
# Load packages
library(tidyverse)
library(janitor)

# Load data
tuna_data <- read_csv("data/raw/CatchByFlagGear/CatchByFlagGear1918-2023.csv") |>
  # Clean column names
  clean_names() |>
  # Rename some columns
  rename(year = ano_year,
         flag = bandera_flag,
         gear = arte_gear,
         species = especies_species,
         catch = t)
```

```
Rows: 13595 Columns: 5
-- Column specification --------------------------------------------------------
Delimiter: ","
chr (3): BanderaFlag, ArteGear, EspeciesSpecies
dbl (2): AnoYear, t

i Use `spec()` to retrieve the full column specification for this data.
i Specify the column types or set `show_col_types = FALSE` to quiet this message.
```

```r
# Check column names
colnames(tuna_data)
```

```
[1] "year"    "flag"    "gear"    "species" "catch"
```

Congratulations, you now have a tidy data set with which we can work! The next steps are to keep the data we care about, calculate revenues, and then calculate summaries. Let's do that.

Part D) Filtering rows with `filter()`

0. **Put your post-it up**
1. What are the unique species represented in the data?
2. What are the fishing gears represented in the data?
3. Does the documentation say what these codes are?[4]
4. What is the species code for bigeye tuna?
5. What is the gear code for purse seine?
6. Create a new object called `ps_tuna_data` that takes the `tuna_data` and filters it to retain data for:
    a. bigeye tuna
    b. caught by tuna purse seiners
    c. since 2000
7. **Remove your post-it when you are done**

```r
# Check unique values for the species column (using a pipe)
tuna_data$species |> unique()
```

```
 [1] "SKJ" "YFT" "SWO" "BZX" "ALB" "PBF" "BET" "BLM" "BUM" "MLS" "CGX" "MZZ"
[13] "BKJ" "BIL" "SKH" "TUN" "DOX" "SFA" "SSP" "SRX" "BXQ"
```

[4]Hint: There is a cryptic link to the reference codes

```r
# Check unique values for the gear colum, without a pipe
unique(tuna_data$gear)
```

```
 [1] "LP"  "PS"  "UNK" "HAR" "LTL" "RG"  "LL"  "GN"  "OTR" "LHP" "TX" 
```

```r
# Create a new data set called ps_tuna_data after filtering
ps_tuna_data <- tuna_data |>
  filter(species == "BET",
         gear == "PS",
         year >= 2000)
```

Part E) Creating new columns with `mutate()`

0. **Put your post-it up**
1. Modify the `ps_tuna_data` pipeline to create a new column called `revenue` that calculates the revenue generated by selling the catch[5]
2. Make sure you calculate revenues in Millions of USD
3. **Remove your post-it when you are done**

```r
# Create a new data set called ps_tuna_data after filtering
ps_tuna_data <- tuna_data |>
  filter(species == "BET", # Retain BET values only
         gear == "PS",      # Retain PS values only
         year >= 2000) |>   # Retain data from 2000 onwards
  mutate(revenue = catch * 1000 * 2 / 1e6) # Calculate revenue
```

Part F) Calculating group summaries with `group_by()` and `summarize()`

0. **Put your post-it up**
1. The data right now report catch at the year-by-flag level. Modify the `ps_tuna_data` pipeline so that we have total catch and revenue by year.[6]
2. **Remove your post-it when you are done**

[5]Hint: If I catch 10 kilos and the price per kilo is US$2, then I make US$20 because $10 * 2 = 20$

[6]Hint: You will need to use the `group_by`, `summarize()`, and `sum()` functions.

```r
ps_tuna_data <- tuna_data |>
  filter(species == "BET", # Retain BET values only
         gear == "PS",      # Retain PS values only
         year >= 2000) |>  # Retain data from 2000 onwards
  mutate(revenue = catch * 1000 * 2 / 1e6) |>  # Calculate revenue
  group_by(year) |>        # Specify that I am grouping by year
  # Tell summarize that I want to collapse the catch column by summing all its values
  summarize(catch = sum(catch),
            revenue = sum(revenue)) # Same, but for revenues
```

! Important

During class we only calculated total revenue. The above code calculates total revenue AND total catch.

Part G) Visualize the data and answer the question

Remember, the question was:

> How much money have tuna purse seiners made since 2000 when fishing for bigeye tuna (*Thunnus obesus*)?

The question is ambiguous because one could answer "They have made X M USD since 2000" or "Every year since 2000, they have made Y M USD per year." So let's get both:

0. **Put your post-it up**
1. What is the total revenue?[7]
2. What is the average annual revenue?[8]
3. Build a time-series showing revenues by year. Make sure to correctly label the axis and include a title and caption describing the figure and the data source, respectively.
4. **Remove your post-it when you are done.**

```r
# Get total revenue
sum(ps_tuna_data$revenue)
```

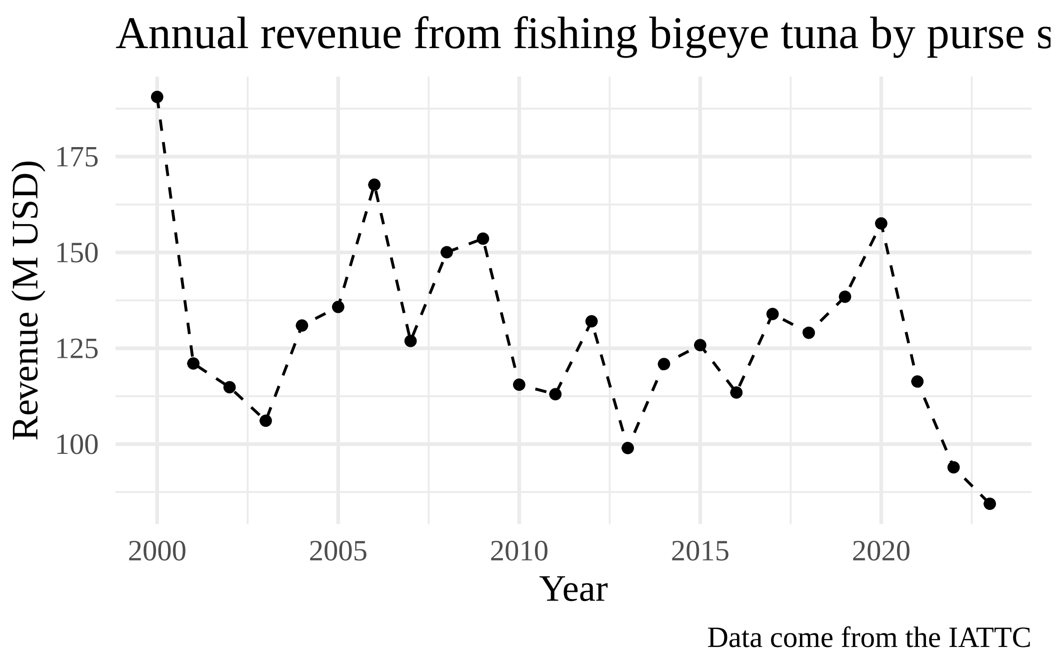
```
[1] 3070.97
```

[7]Hint: Use `$` and `sum()`
[8]Hint: Use `$` and `mean()`

```r
# Get mean annual revenue
mean(ps_tuna_data$revenue)
```

```
[1] 127.9571
```

```r
# Build  plot
ggplot(data = ps_tuna_data,                        # Specify my data
       mapping = aes(x = year, y = revenue)) + # And my aesthetics
  geom_line(linetype = "dashed") +                 # Add a dashed line
  geom_point() +                                   # With points on top
  labs(x = "Year",                                 # Add some labels
       y = "Revenue (M USD)",
       title = "Annual revenue from fishing bigeye tuna by purse seine vessels",
       caption = "Data come from the IATTC") +
  # Modify the theme
  theme_minimal(base_size = 14,                   # Font size 14
                base_family = "Times")            # Font family Times
```

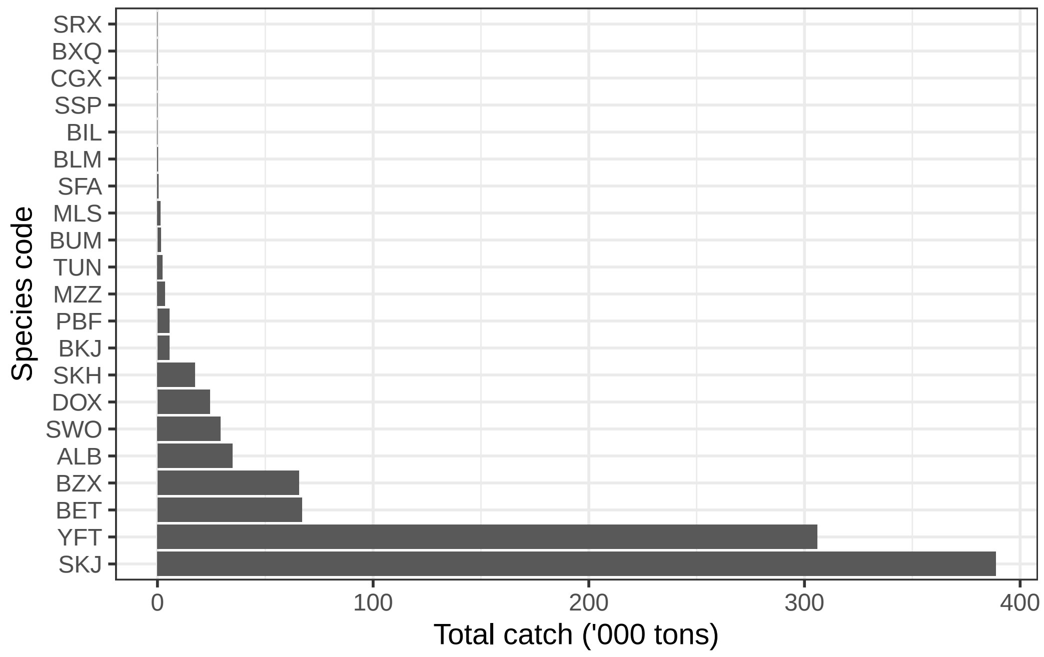


Extra exercises for you to practice

1. Make a figure showing total catch by species during 2023

```r
# Build a new data.frame that has catch by species (in thousand tons)
catch_2023 <- tuna_data |>
  filter(year == 2023) |>
  group_by(species) |>
  summarize(total_catch = sum(catch) / 1e3)

# Now build the figure
ggplot(data = catch_2023,
       aes(x = fct_reorder(species, total_catch, .desc = T), # I am using this fct_reorder to
           y = total_catch)) +
  geom_col() +
  labs(x = "Species code",
       y = "Total catch ('000 tons)") +
  coord_flip() +
  theme_bw()
```



2. Which country caught the most tuna during 2020?

```r
# There is more than one way to do this one
# Option 1

# Build a data that has total catch by country in 2020
```

```r
country_catch <- tuna_data |>
  filter(year == 2020) |>  # Retain only data from 2020
  group_by(flag) |>  # Get total catch by flag (i.e. sum catch across all species)
  summarize(total_catch = sum(catch))

# And then we can use brackets, dollar signs, and boolean operators to extract the flag
country_catch$flag[country_catch$total_catch == max(country_catch$total_catch)]
```

```
[1] "ECU"
```

```r
# Option2: The way I haven't shown you
tuna_data |>
  filter(year == 2020) |>
  group_by(flag) |>
  summarize(total_catch = sum(catch)) |>  # Up until here, the pipeline is the same
  arrange(desc(total_catch)) |> # Then I use the arrange function to sort the data in descend
  head(1) |> # I then retain only the first row, which now _should_ contain the data I want
  pull(flag) # This is a "tidy" version of using a dollar sign to extract a column
```

```
[1] "ECU"
```

3. For each species, identify the year in which catch was at it's maximum

```r
# Option 1: With what you already know
tuna_data |>
  group_by(year, species) |>
  summarize(total_catch = sum(catch)) |> # We firrst calculate total catch by species and yea
  group_by(species) |> # Then we group by species
  filter(total_catch == max(total_catch)) |> # And use the filter function. Since the data ar
  select(species, year_of_max_catch = year) |>  # And we keep the columns we care about
  arrange(species)
```

```
`summarise()` has grouped output by 'year'. You can override using the
`.groups` argument.
```

```
# A tibble: 21 x 2
# Groups:   species [21]
   species year_of_max_catch
   <chr>               <dbl>
 1 ALB                  2014
 2 BET                    2000
 3 BIL                    2013
 4 BKJ                    2016
 5 BLM                    1973
 6 BUM                    1963
 7 BXQ                    2019
 8 BZX                    2023
 9 CGX                    1983
10 DOX                    2009
# i 11 more rows
```

```r
# Option 2: Using slice_max
tuna_data |>
  group_by(year, species) |>
  summarize(total_catch = sum(catch)) |>
  group_by(species) |>
  slice_max(total_catch) |>
  select(species, year_of_max_catch = year) |>
  arrange(species)
```

```
`summarise()` has grouped output by 'year'. You can override using the
`.groups` argument.
```

```
# A tibble: 21 x 2
# Groups:   species [21]
   species year_of_max_catch
   <chr>               <dbl>
 1 ALB                  2014
 2 BET                  2000
 3 BIL                  2013
 4 BKJ                  2016
 5 BLM                  1973
 6 BUM                  1963
 7 BXQ                  2019
 8 BZX                  2023
 9 CGX                  1983
10 DOX                  2009
# i 11 more rows
```

4. How many species have been caught by Mexican-flagged vessels since 2000?

```r
# Option 1: A pipeline that ends in a vector, with unique and length
# Start from tuna_data
tuna_data |>
  filter(flag == "MEX") |>  # Retain observations associated with Mexico
  pull(species) |> # Pull the species column away from the data.frame, at this point we have
  unique() |> # Get a unique list of species
  length() # Count the number of unique species
```

```
[1] 21
```

```r
# Alternatively, retain the data.frame structure
tuna_data |>
  filter(flag == "MEX") |>   # Retain observations associated with Mexico
  group_by(flag) |>
  summarize(n_species = n_distinct(species)) # The n_distinct() function is a tidy version o
```

```
# A tibble: 1 x 2
  flag  n_species
  <chr>     <int>
1 MEX          21
```

Sibert, John, Inna Senina, Patrick Lehodey, and John Hampton. 2012. "Shifting from Marine Reserves to Maritime Zoning for Conservation of Pacific Bigeye Tuna (Thunnus Obesus)." *Proc. Natl. Acad. Sci. U. S. A.* 109 (October): 18221–25.