# Data Management and Transformation

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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

[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.

## 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**

```
# 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: ","
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.
```

```
# 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.

[3] Hint: use the `colnames()` function

Let's also rename `t` as `catch`

6. **Remove your post-it when you are done**

```
# 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.
```

```
# 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:

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

    a. bigeye tuna
    b. caught by tuna purse seiners
    c. since 2000
7. **Remove your post-it when you are done**

```
# 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"
```

```
# 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"
```

```
# 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**

```
# 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
```

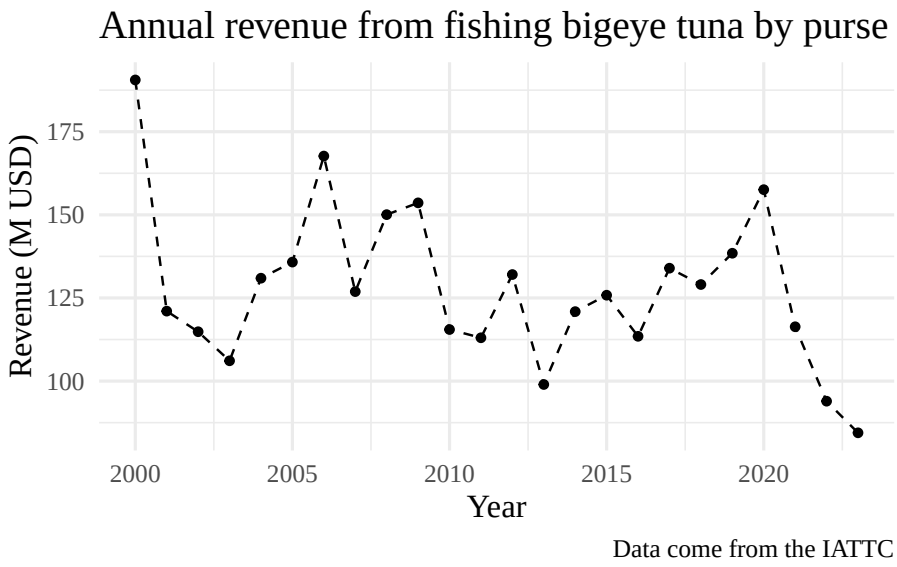
```r
# Get mean annual revenue
mean(ps_tuna_data$revenue)
```

```
[1] 127.9571
```

```r
# Build  plot
ggplot(data = ps_tuna_data,                    # Specify my data
```

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

```
      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
```



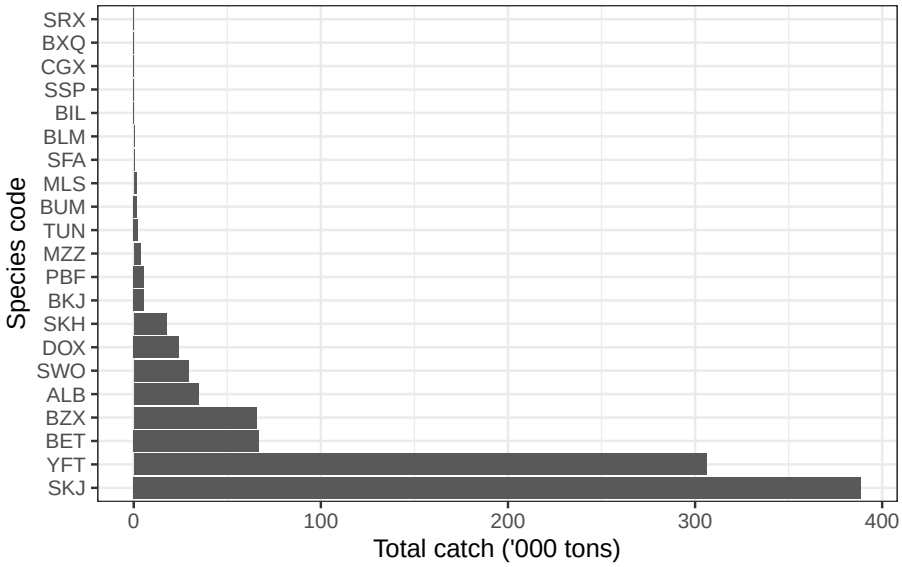

## Extra exercises for you to practice

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

```
# 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 t
           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?

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

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

```
# 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 descen
  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

```
# 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 ye
  group_by(species) |> # Then we group by species
  filter(total_catch == max(total_catch)) |> # And use the filter function. Since the data a
  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
```

```
# 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?

```
# 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
```

```
# 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.