

Covid-19 and Global Fishing Activity

Juliet Cohen

12/1/2021

Covid-19 and Global Fishing Activity

2020 is a year we will never forget. Covid-19 spread rapidly across the globe and forced most of humanity into a state of quarantine. Covid-19 had clear devastating impacts on economies of all scales. Travel was heavily limited, and even when crossing country borders was possible, it was heavily monitored. However, the pandemic boosted some sectors of the economy and increased demand for certain goods. How did Covid-19 impact fishing activity? Did fisheries respond to the pandemic by sending fishermen and fisherwomen home to quarantine, or did some countries see this as an opportunity to fish in the high seas more than ever before? Regulating fishing and other vessel activities across the globe is a challenge in itself (Anticamara et al. 2011). Databases often have large gaps due to various causes such as a lack of reliable data from automatic identification systems and voluntary vessel registration by the owners of the vessels. Global Fishing Watch is an organization that aims to revolutionize the way we monitor fishing activity across the world using remote sensing techniques from satellites combined with automatic identification systems. Global Fishing Watch collects and visualizes global fishing data with the goal of embracing ocean sustainability, transparency, and open-source science. They keep track of vessels from all different countries, including their movements, boat types, and time stamps for fishing and docking at ports. Without such efforts to monitor, publicize, and regulate ocean activity, our marine resources are at high risk of depletion. On a global scale, we are fishing faster than fish stocks can naturally replenish. This has severe economic impacts; according to the World Bank Report, the ensuing depletion of marine fish stocks causes economic losses of 50 billion US dollars annually (Anticamara et al. 2011). With modern data science and applied statistics, we can better understand fishing activity on a global scale and protect our planet's marine biodiversity.

As an aspiring wildlife biologist and data scientist, I'm interested in applying statistical analysis to Global Fishing Watch data to learn how different countries' fishing effort changed in 2020, relative to those countries' fishing trends in the years leading up to 2020. In this dataset, fishing effort is defined by the amount of hours spent fishing. With Global Fishing Watch's expansive open-source data collection, we can approach this question by grouping all vessels' fishing hours by country, identifying a statistical trend up until 2019, and extrapolating that trend into 2020. By comparing this 2020 prediction to the actual fishing data available for 2020, we can glean how Covid-19 skewed large-scale fishing efforts. Perhaps the global fishing economy sky-rocketed, plummeted into near nonexistence, or remained unscathed by the pandemic. Quantitative analysis will help provide some insight.

Global Fishing Watch offers an interactive map that displays fishing activity across the globe through a heat map. This visualization has the potential to inspire data scientists, fish enthusiasts, environmental justice advocates, pandemic researchers, and everyone in between to examine fishing activity during a time period of interest.

Global fishing activity from January 1, 2019 through January 1, 2020.

Global fishing activity from January 1, 2020 through January 1, 2021. Global Fishing Watch and their partners also provide an interactive map that allows users to interact with vessels across the globe, filter by country, and overlay port locations on coastlines.

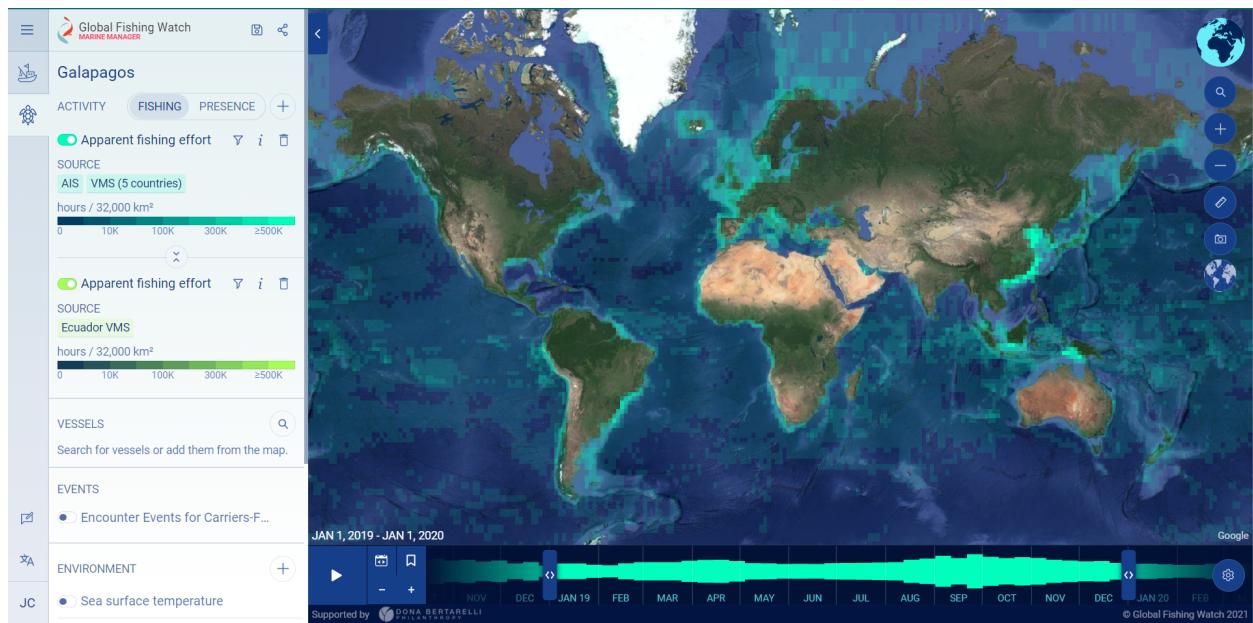


Figure 1: “2019 Global Fishing Activity”

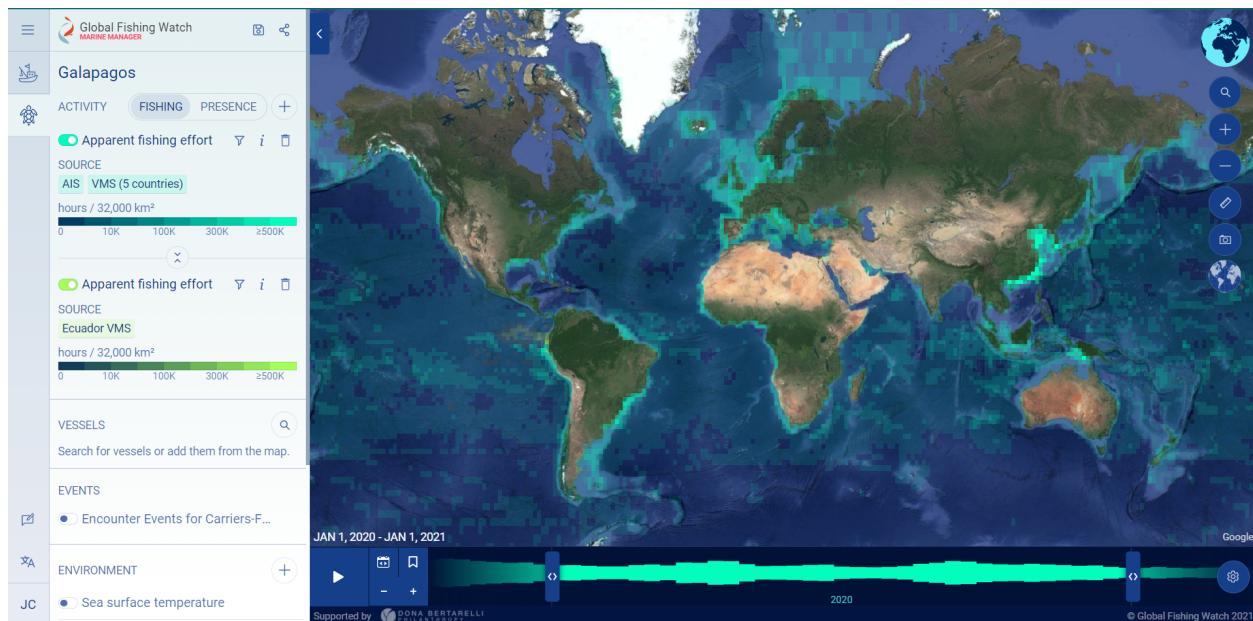


Figure 2: “2020 Global Fishing Activity”

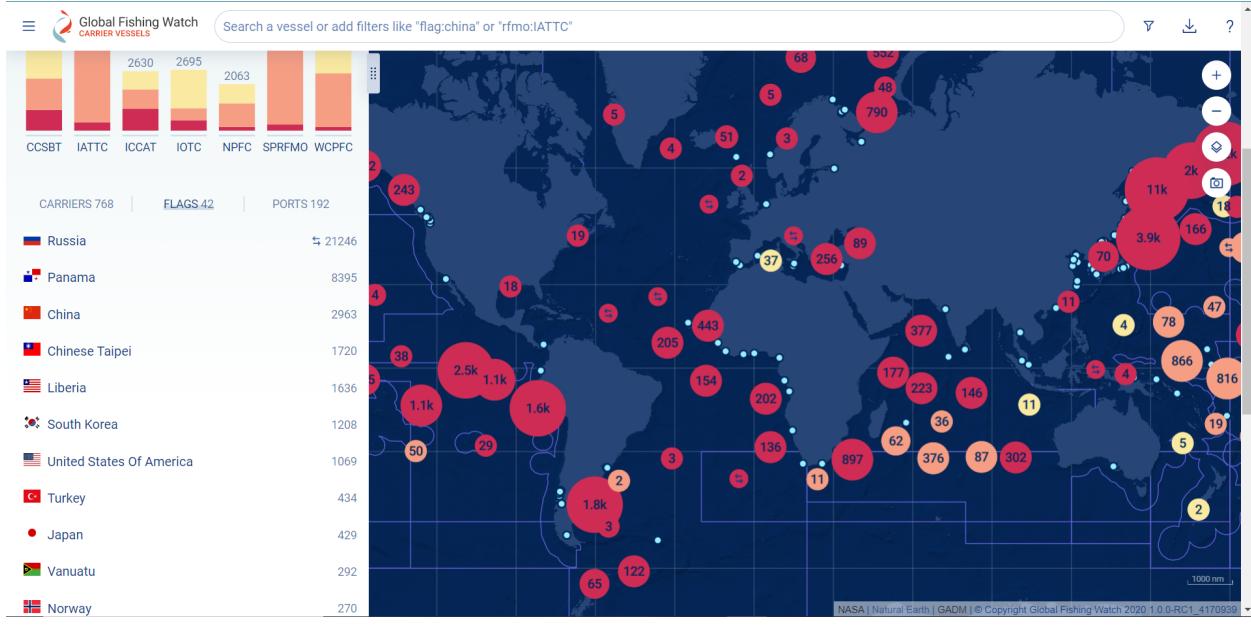


Figure 3: “Fishing Vessels by Country”

Global vessel activity by country from January 1, 2017 through September 30, 2021 First things first, let’s import our necessary R packages and the dataset from Global Fishing Watch that includes country identification for each vessel as well as fishing hours by year:

Data source: Global Fishing Watch: Datasets and Code, fishing effort data

Data Cleaning and Wrangling

This dataset includes fishing effort and vessel information from 124 countries over the years 2012-2020. First, we select our variables of interest, group by country, and take the fishing effort means per year.

Our goal is to run a linear regression on each country’s fishing effort over multiple years, but many countries have NA data for certain years. Considering that we have data available for 2012-2020, which years should we choose? We want to select a chunk of continuous years leading up to 2020 with minimal data gaps. We want to minimize the amount of NA values because we will drop all rows with NA values, and we want to maintain the maximum amount of rows (which represent vessels) and countries as possible. In order to choose the start year for the time period that we will feed into the linear regression, let’s take a look at the amount of NA values in the years leading up to 2020.

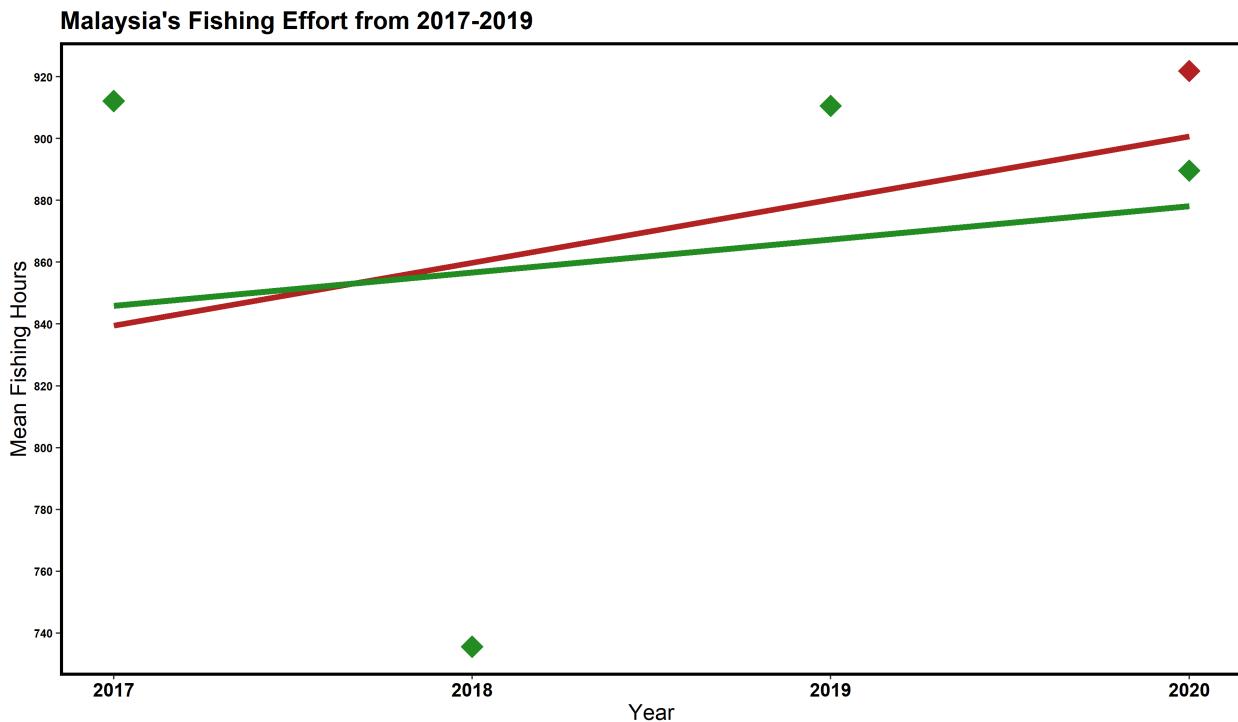
2017 has the least amount of NA values, so we will use that year to start our 3-year data period to feed to the linear regression. Next, we convert the data into **Tidy** format and remove NA values so we can run a time series linear regression analysis.

Our dates are in years, and currently their class is **character**. We need these years in **date** format in order to run a linear regression over time. We will convert these years and remove all countries that only have data for 2 years, because we need multiple years of data to feed into the regression and we want each country to have equal amounts of data and start in the year 2017.

By feeding the output of these linear models into a for loop, we can plug in each country’s fishing effort intercept and slope into a linear equation to predict the fishing effort in 2020 based on that country’s historical trend. We

Combine the predicted 2020 fishing effort data with the actual 2020 fishing effort data into a single dataframe to compare by country. We can even add a column that explicitly states whether that country increased or decreased their fishing effort in 2020 relative to their trend leading up to 2020.

Plotting Actual Fishing Effort versus Predicted Fishing Effort for Malaysia



Statistical Significance

It's time to run a t-test to determine if there is a statistical difference between the countries' predicted fishing effort in 2020 and their actual fishing effort in 2020. A t-test is a handy tool in statistics that reveals how significant the differences between groups are. If the difference between the means of two groups could have easily happened by chance, the p-value will be greater than 0.05 (which is the standard threshold in statistics and environmental data science). If it is highly unlikely (less than a 5% chance) that a difference in means at least this extreme could have occurred by chance, the p-value is less than 0.05 and the results are considered statistically significant. A statistically significant outcome allows us to reject our **null hypothesis**.

Null Hypothesis: There is no difference between the predicted country-specific predicted fishing effort in 2020 and the actual country-specific fishing effort in 2020.

$$H_0 : \mu_{predicted} - \mu_{actual} = 0$$

Alternative Hypothesis: There is a difference between the predicted country-specific predicted fishing effort in 2020 and the actual country-specific fishing effort in 2020. Because of the pandemic in 2020, I predict that fishing effort decreased, meaning that the actual country-specific fishing effort is less than the predicted country-specific fishing effort.

$$H_A : \mu_{predicted} - \mu_{actual} \neq 0$$

Don't forget to convert the data to **Tidy format** so we can run the t-test!

```
Welch Two Sample t-test

data: mean_effort by actual_or_predicted
t = -6.2015, df = 72.282, p-value = 0.0000000312
alternative hypothesis: true difference in means between group actual_2020 and group prediction_2020 is not
equal to 0
95 percent confidence interval:
-6761.425 -3472.097
sample estimates:
mean in group actual_2020 mean in group prediction_2020
1406.727               6523.488
```

Figure 4: **t-test output**

The p-value is 0.0000000312, and $0.0000000312 < 0.05$, so we can reject our null hypothesis that there is no difference between the predicted country-specific predicted fishing effort in 2020 and the actual country-specific fishing effort in 2020. Many countries clearly changed their fishing effort in 2020 relative to their historical trend!

To best visualize this fishing effort data in a table, we can color code the countries that **increased** their fishing effort as red and color the countries that **decreased** their fishing effort in green.

Which countries increased or decreased 2020 fishing effort relative to their trend?

| Country Code | Difference: Prediction - Actual | Fishing Effort Relative to Trend |
|--------------|------------------------------------|-------------------------------------|
| AGO | 18,839.60 | fished LESS than trend |
| ARG | 1,589.04 | fished LESS than trend |
| AUS | 2,912.65 | fished LESS than trend |
| BEL | -1,957.92 | fished MORE than trend |
| BHR | 1,096.14 | fished LESS than trend |
| CHN | -483.96 | fished MORE than trend |
| CIV | -1,716.01 | fished MORE than trend |
| COL | 7,640.26 | fished LESS than trend |
| CWY | 679.30 | fished LESS than trend |
| CYP | 893.07 | fished LESS than trend |
| DEU | 1,132.22 | fished LESS than trend |
| DNK | 1,138.36 | fished LESS than trend |
| DZA | 966.74 | fished LESS than trend |
| FIN | 1,181.76 | fished LESS than trend |
| FLK | 8,901.31 | fished LESS than trend |
| FRA | 3,911.13 | fished LESS than trend |
| FRO | 17,991.09 | fished LESS than trend |
| FSM | 10,412.30 | fished LESS than trend |
| GBR | -696.23 | fished MORE than trend |
| GNB | 2,829.85 | fished LESS than trend |
| GRC | 1,090.50 | fished LESS than trend |
| GRL | -1,740.20 | fished MORE than trend |
| GTM | 9,408.47 | fished LESS than trend |
| HKG | 1,135.99 | fished LESS than trend |
| HND | -499.66 | fished MORE than trend |
| HRV | 1,312.42 | fished LESS than trend |
| IND | 2,115.41 | fished LESS than trend |
| IRL | 1,781.87 | fished LESS than trend |
| IRN | 10,708.15 | fished LESS than trend |
| ITA | 455.14 | fished LESS than trend |
| JPN | 7,306.61 | fished LESS than trend |
| KIR | 22,066.68 | fished LESS than trend |
| KOR | 1,961.90 | fished LESS than trend |
| LBR | 3,835.59 | fished LESS than trend |
| LTU | 965.70 | fished LESS than trend |
| LVA | 3,866.25 | fished LESS than trend |
| MEX | 183.88 | fished LESS than trend |
| MHL | 4,459.09 | fished LESS than trend |
| MLT | 3,403.21 | fished LESS than trend |
| MOZ | 30,463.68 | fished LESS than trend |
| MRT | 3,967.54 | fished LESS than trend |
| MUS | 4,556.00 | fished LESS than trend |
| MYS | -32.19 | fished MORE than trend |
| NCL | 16,767.26 | fished LESS than trend |
| NIC | 12,025.34 | fished LESS than trend |
| NLD | 5,488.85 | fished LESS than trend |
| NOR | 637.39 | fished LESS than trend |
| NRU | 23,059.46 | fished LESS than trend |
| NZL | 3,033.13 | fished LESS than trend |
| PHL | 4,969.43 | fished LESS than trend |
| PNG | 6,850.56 | fished LESS than trend |
| POL | 2,654.60 | fished LESS than trend |
| PRT | 5,154.99 | fished LESS than trend |
| PYF | 14,175.31 | fished LESS than trend |
| ROU | 7,758.79 | fished LESS than trend |
| RUS | 6,501.55 | fished LESS than trend |
| SAU | 1,057.84 | fished LESS than trend |
| SEN | -1,264.19 | fished MORE than trend |
| SLV | 4,308.69 | fished LESS than trend |
| SVN | 6,581.25 | fished LESS than trend |
| SYC | 7,965.57 | fished LESS than trend |
| TCA | 2,742.51 | fished LESS than trend |
| TUV | -235.40 | fished MORE than trend |
| UKR | 9,779.68 | fished LESS than trend |
| UNK | -327.21 | fished MORE than trend |
| URY | 1,521.12 | fished LESS than trend |
| USA | 148.03 | fished LESS than trend |
| VEN | 2,640.55 | fished LESS than trend |
| VUT | 9,212.82 | fished LESS than trend |
| ZAF | -872.42 | fished MORE than trend |

Data Source: Global Fishing Watch: <https://globalfishingwatch.org/datasets-and-code/>

Resources:

- Global Fishing Watch website
- Global Fishing Watch: Datasets and Code, Fishing effort data
- note: Users must make a free account in order to access datasets
- World Maps of Fishing Activity: Pictures 1 & 2 - Global Fishing Watch
- World Map of Fishing by Country: Picture 3 - Global Fishing Watch
- Anticamara, J. A., R. Watson, A. Gelchu, and D. Pauly. "Global Fishing Effort (1950–2010): Trends, Gaps, and Implications." *Fisheries Research* 107, no. 1 (2011): 131–36. <https://doi.org/10.1016/j.fishres.2010.10.016>.

Acknowledgements:

- I would like to acknowledge Dr. Tamara Carleton, my professor in Statistics for Environmental Data Science at the U.C. Santa Barbara Bren School for Environmental Science and Management, for all her support throughout this project and this quarter.
- I would also like to thank my peers in the Master of Environmental Data Science Program for being so open to collaboration and supporting each other with resources, programming tools, and open-source science.
- Lastly, I would like to thank Global Fishing Watch for inspiring me to give a hoot about global fishing effort by country, and for providing the data that made this project possible.

Distill is a publication format for scientific and technical writing, native to the web.

Learn more about using Distill at <https://rstudio.github.io/distill>.