trans

October 12, 2022

1 Transshipments

[47]:
```
import pandas as pd
import numpy as np
import seaborn as sns
import matplotlib.pyplot as plt
import matplotlib.ticker as mtick
import pycountry
```

[166]:
```
sns.set_style('white')
sns.set_context("paper", font_scale = 1.2)
color = sns.color_palette("tab10", 10)[0]
```

[167]:
```
wd = "/Users/sebastiandodt/OneDrive/Uni/Carnegie Mellon University/Modules/2022␣
 ↪Fall/Systems Project/Coding/90739-iuu-systems-project/"
```

[ ]:
```
carrier = pd.read_excel(wd + 'port_evaluation/data/proc/GFW/gfw_data-v2.xlsx',␣
 ↪sheet_name='carriers')
loiter = pd.read_csv(wd + 'port_evaluation/data/input/GFW/unified/loitering.
 ↪csv')
encounter = pd.read_csv(wd + 'port_evaluation/data/input/GFW/unified/encounter.
 ↪csv')
port_visit = pd.read_csv(wd + 'port_evaluation/data/input/GFW/unified/
 ↪port_visit.csv')
```

[169]:
```
loiter2 = pd.read_excel(wd + 'port_evaluation/data/proc/GFW/gfw_data-v2.xlsx',␣
 ↪sheet_name='loitering') ## data that contains average distance to shore
```

[170]:
```
eez = pd.read_csv(wd + 'port_evaluation/data/input/EEZ/eez.csv')
```

[171]:
```
country_data = [[country.alpha_3, country.alpha_2, country.name] for country in␣
 ↪pycountry.countries]
country_data = pd.DataFrame(country_data, columns=['alpha_3', 'alpha_2',␣
 ↪'flag_country'])
rename_dict = {'Korea, Republic of': 'Korea', 'Taiwan, Province of China':␣
 ↪'Taiwan', 'Russian Federation': 'Russia'}
for country in rename_dict.keys():
```

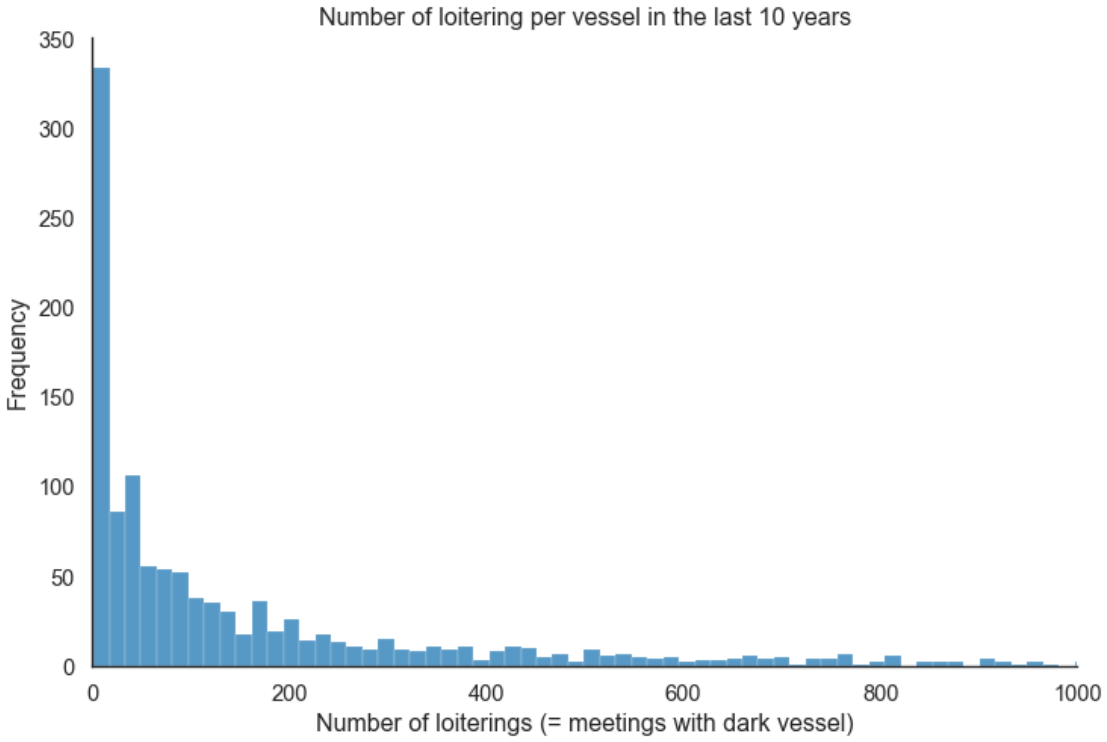
```
    country_data.loc[country_data['flag_country'] == country, 'flag_country'] =␣
 ↪rename_dict[country]
```

Preprocessing

[172]:
```
## merging loitering with carrier data
carrier['imo'] = carrier['imo'].replace(0,np.nan)
carriers = carrier.merge(country_data, left_on='flag', right_on='alpha_3',␣
 ↪how='left')
loitering = loiter.merge(carriers, left_on='vessel.id', right_on='id',␣
 ↪how='left', suffixes=('_loitering', '_carrier')) ## all but 2 vessel.ids␣
 ↪match between datasets.
```

Summary statistics

[173]:
```
plot_data = loitering.loc[:,'imo'].value_counts().reset_index()
sns.displot(data=plot_data, x="imo", kind="hist", bins = 300, aspect = 1.5)
plt.xlim(0,1000)
plt.title('Number of loitering per vessel in the last 10 years')
plt.xlabel('Number of loiterings (= meetings with dark vessel)')
plt.ylabel('Frequency')
plt.show()
print("The median is {median}.".format(median=plot_data['imo'].median()))
```

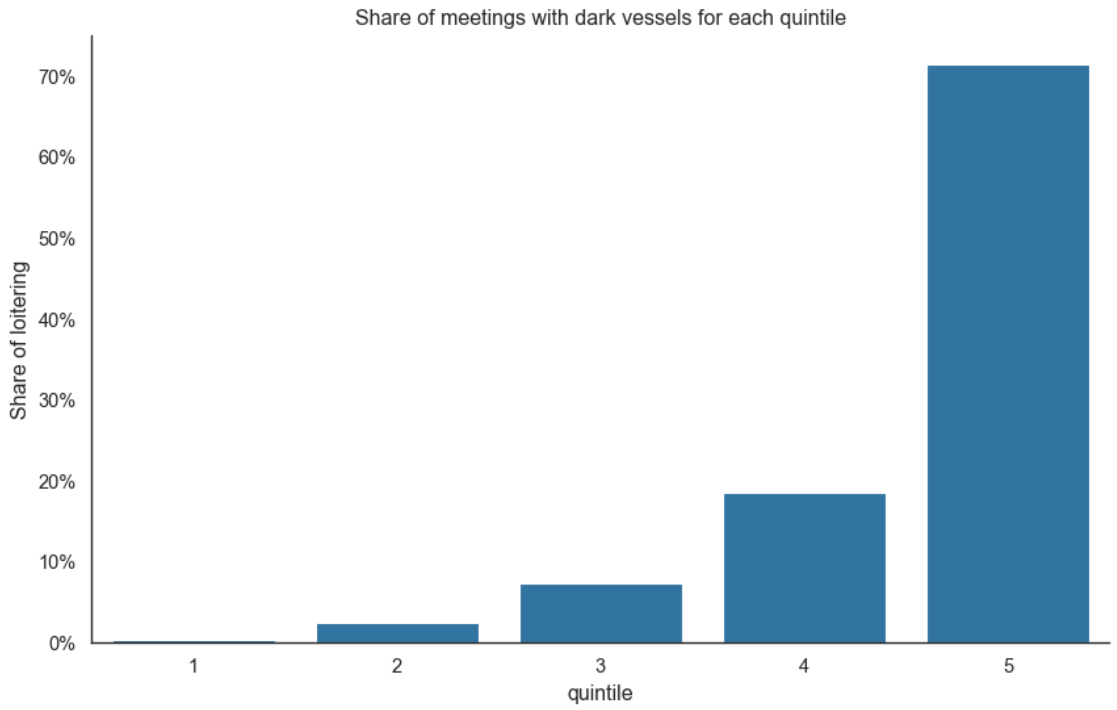


```
The median is 73.0.
```

Share responsible

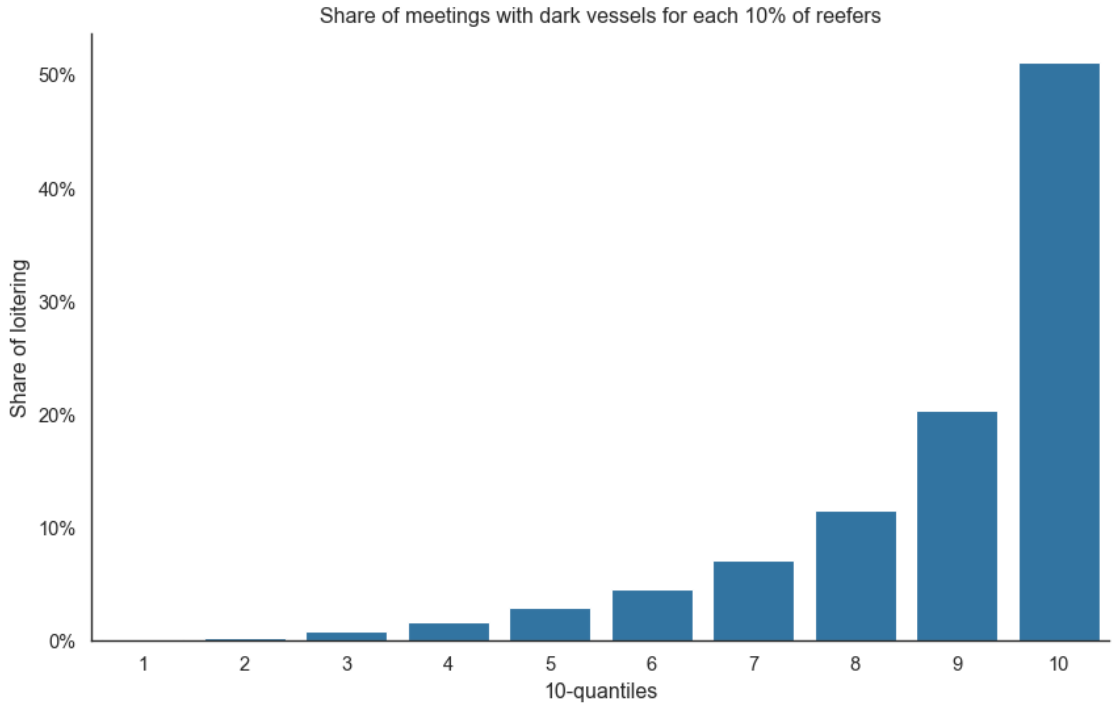
[174]:
```
running_sum = 0
sum = []
share = []
for quintile in range(0,5):
    quantile = (quintile + 1)/5
    amount = plot_data['imo'].quantile(quantile)
    sum.append(plot_data.loc[plot_data['imo']<=amount,'imo'].sum() -␣
 ↪running_sum)
    running_sum += sum[-1]
    share.append(sum[-1]/plot_data['imo'].sum() * 100)
quintiles = pd.DataFrame({'quintile' : range(1,6), 'share': share})

fig, ax = plt.subplots(figsize=(10, 6))
sns.barplot(x = "quintile",
              y = "share",
              data = quintiles,
              ax = ax,
              color=color)
handles, labels = ax.get_legend_handles_labels()
sns.despine(right = True)
plt.ylabel('Share of loitering')
ax.yaxis.set_major_formatter(mtick.PercentFormatter())
plt.title('Share of meetings with dark vessels for each quintile')
plt.show()
```



[177]:
```
running_sum = 0
sum = []
share = []
for quintile in range(0,10):
    quantile = (quintile + 1)/10
    amount = plot_data['imo'].quantile(quantile)
    sum.append(plot_data.loc[plot_data['imo']<=amount,'imo'].sum() -␣
 ↪running_sum)
    running_sum += sum[-1]
    share.append(sum[-1]/plot_data['imo'].sum() * 100)
quintiles = pd.DataFrame({'10-quantiles' : range(1,11), 'share': share})

fig, ax = plt.subplots(figsize=(10, 6))
sns.barplot(x = "10-quantiles",
              y = "share",
              data = quintiles,
              ax = ax,
              color=color)
handles, labels = ax.get_legend_handles_labels()
sns.despine(right = True)
plt.ylabel('Share of loitering')
ax.yaxis.set_major_formatter(mtick.PercentFormatter())
plt.title('Share of meetings with dark vessels for each 10% of reefers')
plt.show()
```



Cutoff for loitering

[ ]:
```
plot_data['imo'].quantile(.9)
```

[ ]:
```
546.8000000000002
```

Number of ships

[ ]:
```
len(plot_data.loc[plot_data['imo']>=549.49,'imo'])
```

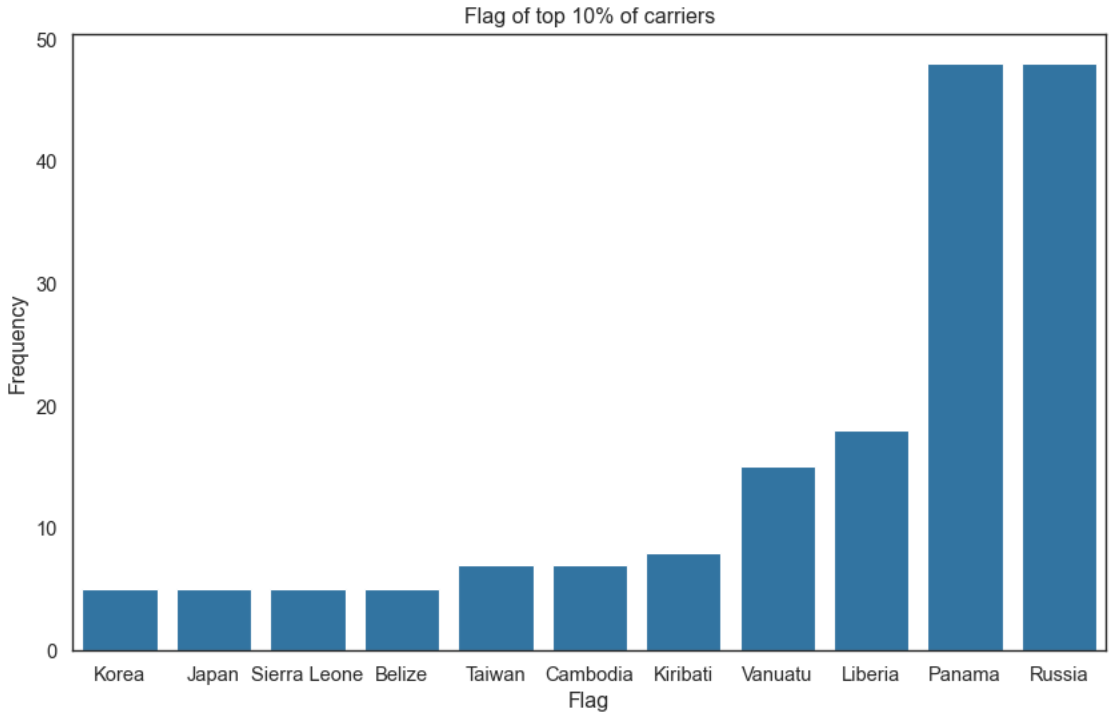
[ ]:
```
120
```

[ ]:
```
top_10_percent = plot_data.loc[plot_data['imo']>=549.49,:]
loitering_top = loitering.loc[loitering['imo'].isin(top_10_percent['index']),:]
```

[ ]:
```
plot_data2 = top_10_percent.rename({'imo': 'n_dark_meetups'}, axis=1).
 ↪merge(carriers, how='left', left_on='index', right_on='imo')
plot_data3 = plot_data2.groupby('flag_country')['imo'].nunique().reset_index().
 ↪sort_values('imo')
# sns.displot(data=plot_data2, x="flag", kind="hist", bins = 300, aspect = 1.5)
# plt.show()
```

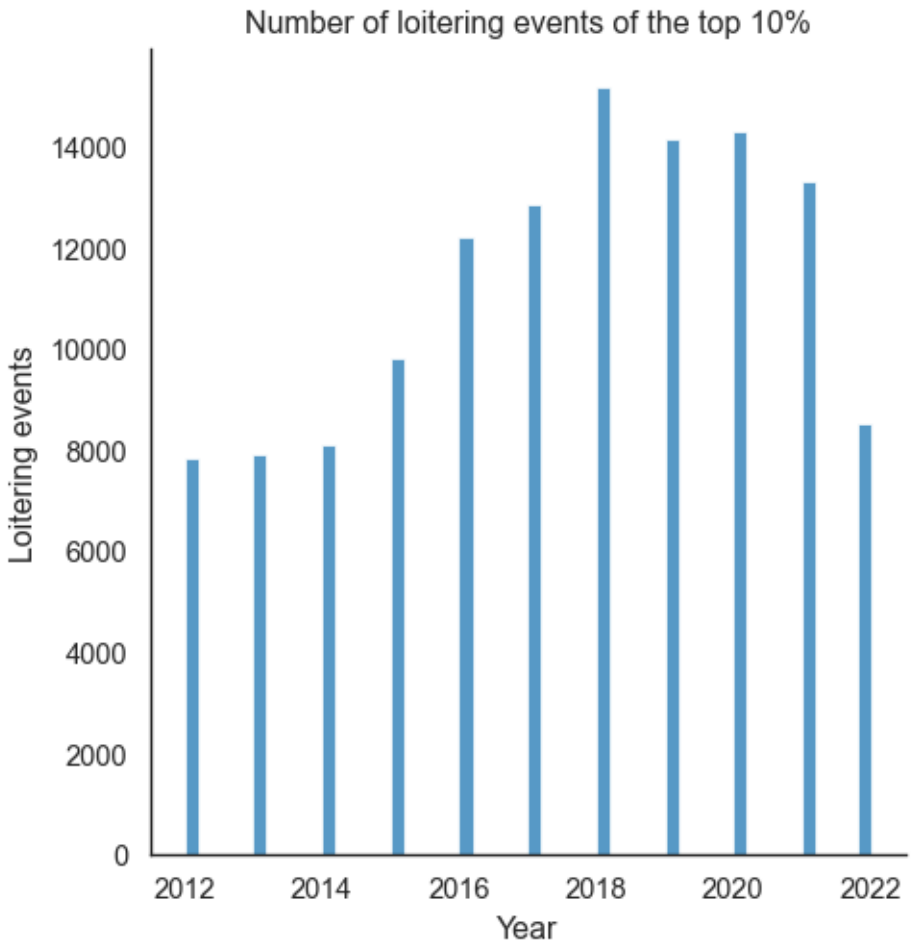
[178]:
```
fig, ax = plt.subplots(figsize=(10, 6))
sns.barplot(data=plot_data3.iloc[21:,:],
    x='flag_country',
```

```
    y='imo',
    ax = ax,
    color=color)
plt.title('Flag of top 10% of carriers')
plt.ylabel('Frequency')
plt.xlabel('Flag')
plt.show()
```



Time

[193]:
```
loitering_top['start_dt'] = pd.to_datetime(loitering_top['start'])
loitering_top['year'] = loitering_top['start_dt'].dt.year
sns.displot(data=loitering_top, x="year", kind="hist")
plt.title('Number of loitering events of the top 10%')
plt.ylabel('Loitering events')
plt.xlabel('Year')
plt.show()
```



Additional analysis:

- which boats they each encountered
- length and size (using SeaVision)

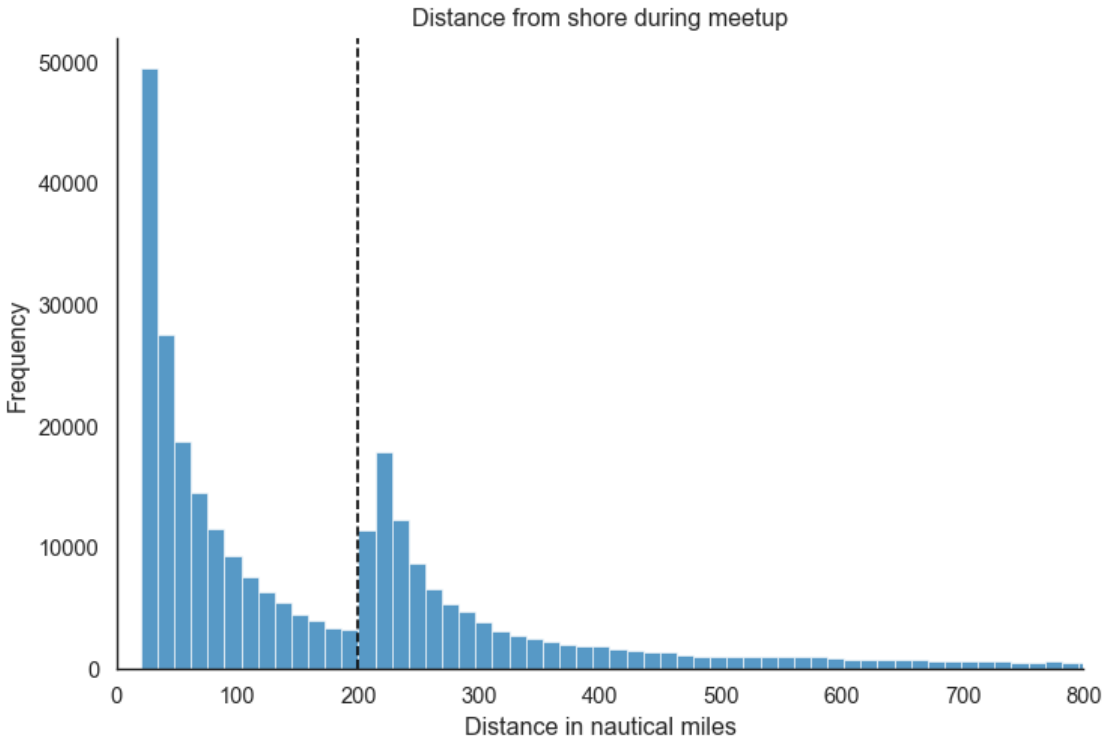
1.1 Location of meetups

EEZ

[ ]:
```
loiter2['averageDistanceFromShorenm'] = loiter2['averageDistanceFromShoreKm'] /␣
↪1.852
```

[ ]:
```
fig = sns.displot(data=loiter2, x="averageDistanceFromShorenm", kind="hist",␣
↪bins = 100, aspect = 1.5)
plt.axvline(200,c='black',linestyle='--')
plt.xlim(0,800)
plt.title('Distance from shore during meetup')
plt.xlabel('Distance in nautical miles')
```

```
plt.ylabel('Frequency')
plt.show()
```



[ ]:
```
loiter2['eez'].isna().sum()/len(loiter2)
```

[ ]:
```
0.4066901785523056
```

40% of dark meet-ups in EEZ

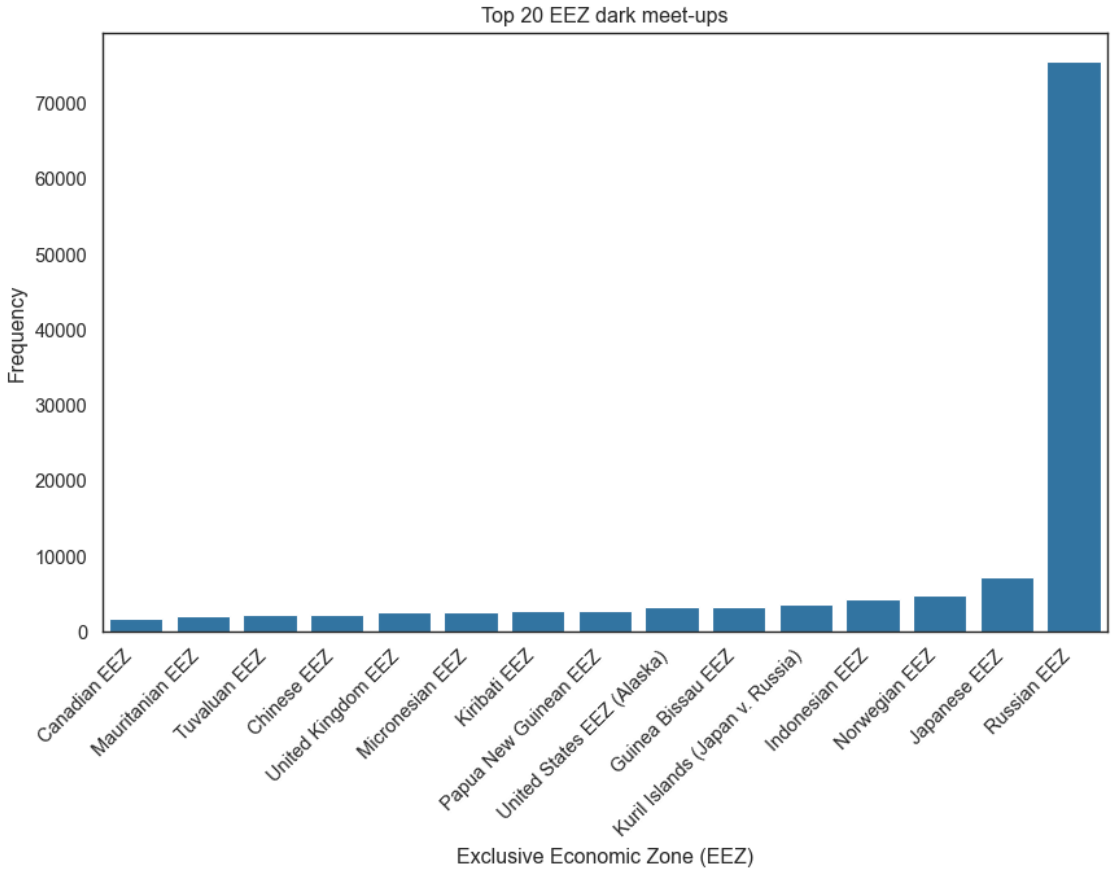
[ ]:
```
plot_data4 = loiter2.groupby('eez')['event_id'].nunique().reset_index().
 ↪sort_values('event_id')
plot_data4 = plot_data4.set_index(plot_data4.columns.drop('eez',1).tolist()) \
    .eez.str.split(',', expand=True) \
    .stack() \
    .reset_index() \
    .rename(columns={0:'eez'}) \
    .loc[:, plot_data4.columns] \
    .groupby('eez')['event_id'] \
    .sum() \
    .reset_index() \
    .sort_values('event_id')
```

[ ]:
```
eez['MRGID_new'] = eez['MRGID'].astype(str)
```

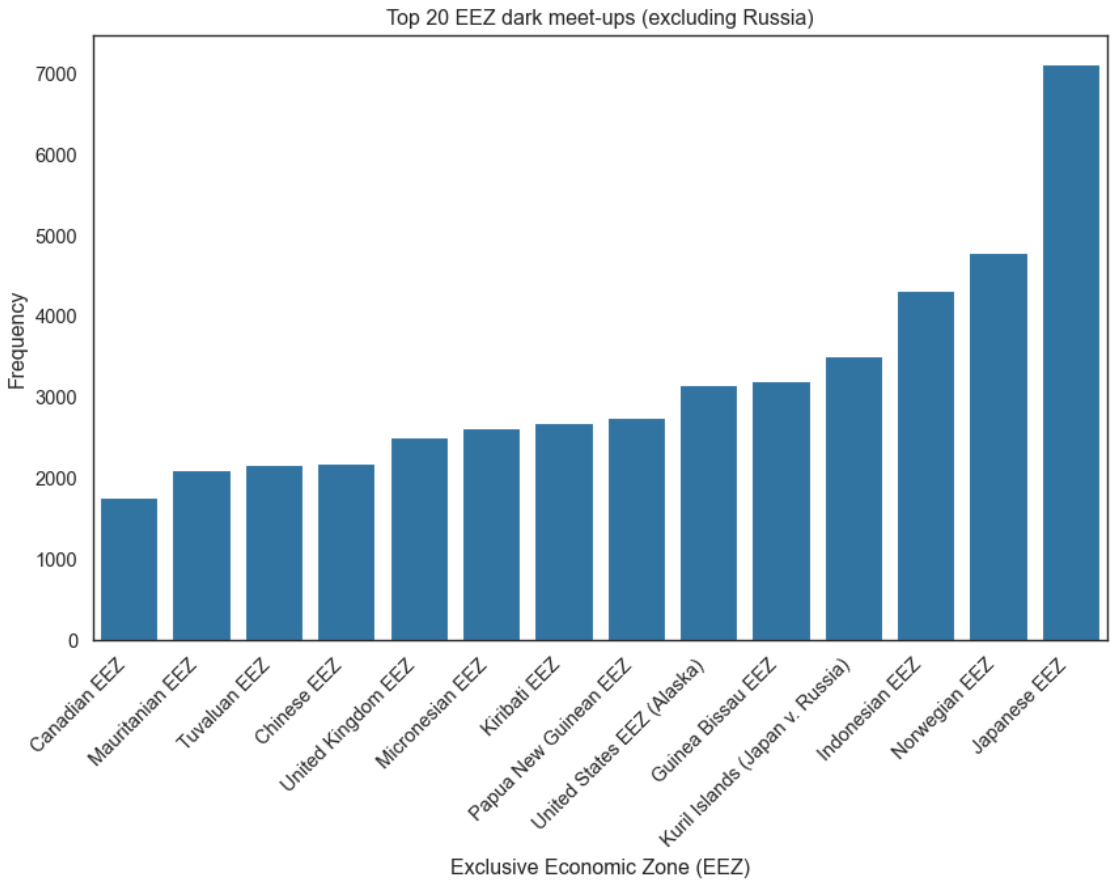
[ ]:
```
plot_data4 = plot_data4.merge(eez, left_on='eez', right_on='MRGID_new',␣
 ↪how='left').reset_index(drop=True)
```

[ ]:
```
additional = {
    '8487': 'Japanese Exclusive Economic Zone',
    '8492': 'Indonesian Exclusive Economic Zone',
    '48950': 'Kuril Islands (Japan v. Russia)',
    '8471': 'Guinea Bissau Exclusive Economic Zone',
    '8463': 'United States Exclusive Economic Zone (Alaska)',
    '8488': 'Kiribati Exclusive Economic Zone',
    '8486': 'Chinese Exclusive Economic Zone',
    '8493': 'Canadian Exclusive Economic Zone',
}
for eez in additional.keys():
    plot_data4.loc[plot_data4['eez']==eez, 'preferredGazetteerName'] =␣
 ↪additional[eez]
# for row in range(len(plot_data4)):
plot_data4['preferredGazetteerName'] = \
    plot_data4['preferredGazetteerName'] \
        .str.replace('Exclusive Economic Zone', 'EEZ')
plot_data4['preferredGazetteerName'] = \
    plot_data4['preferredGazetteerName'] \
        .str.replace('Exclusive economic Zone', 'EEZ')
```

[179]:
```
fig, ax = plt.subplots(figsize=(10, 6))
sns.barplot(data=plot_data4.iloc[-20:,:],
    x='preferredGazetteerName',
    y='event_id',
    ax = ax,
    color=color)
ax.set_xticklabels(ax.get_xticklabels(), rotation=45,␣
 ↪horizontalalignment='right')
plt.title('Top 20 EEZ dark meet-ups')
plt.ylabel('Frequency')
plt.xlabel('Exclusive Economic Zone (EEZ)')
plt.show()
```



[180]:
```
fig, ax = plt.subplots(figsize=(10, 6))
sns.barplot(data=plot_data4.iloc[-20:-1,:],
    x='preferredGazetteerName',
    y='event_id',
    ax = ax,
    color=color)
ax.set_xticklabels(ax.get_xticklabels(), rotation=45,␣
 ↪horizontalalignment='right')
plt.title('Top 20 EEZ dark meet-ups (excluding Russia)')
plt.ylabel('Frequency')
plt.xlabel('Exclusive Economic Zone (EEZ)')
plt.show()
```

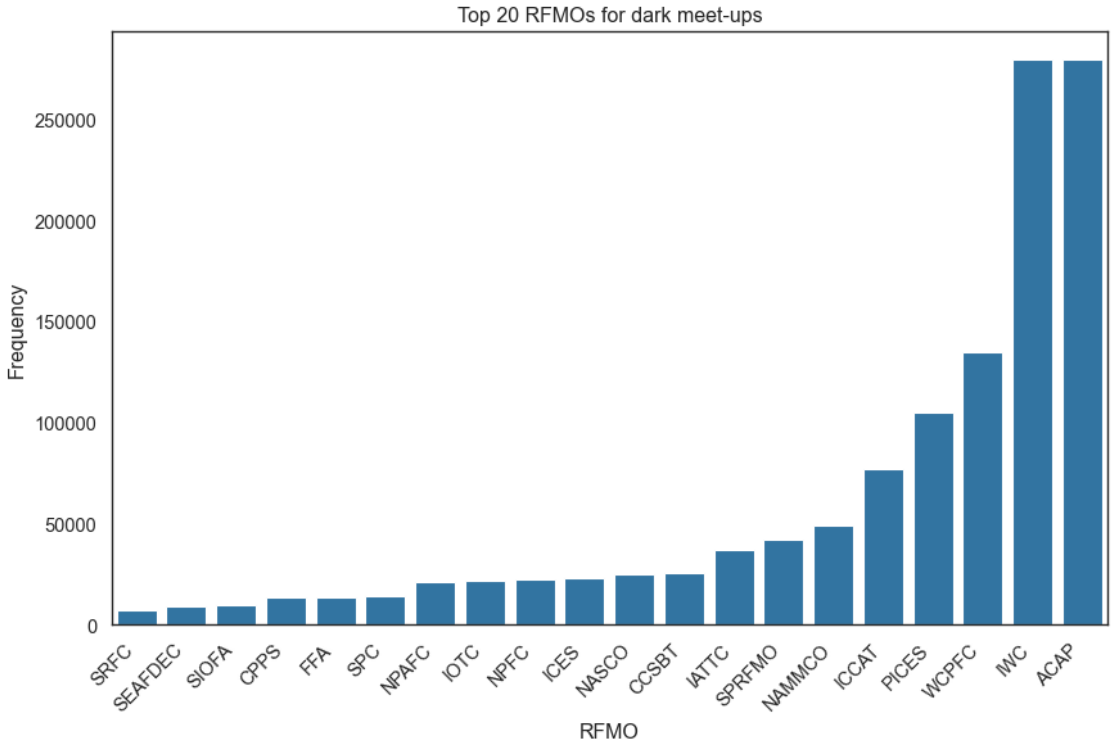


RFMOs

[ ]:
```
plot_data5 = loitering \
    .rename({'regions.rfmo': 'rfmo'}, axis=1) \
    .groupby('rfmo')['id_loitering'] \
    .nunique() \
    .reset_index() \
    .sort_values('id_loitering')
plot_data5 = plot_data5.set_index(plot_data5.columns.drop('rfmo',1).tolist()) \
    .rfmo.str.split(',', expand=True) \
    .stack() \
    .reset_index() \
    .rename(columns={0:'rfmo'}) \
    .loc[:, plot_data5.columns] \
    .groupby('rfmo')['id_loitering'] \
    .sum() \
    .reset_index() \
    .sort_values('id_loitering')
plot_data5 = plot_data5.set_index(plot_data5.columns.drop('rfmo',1).tolist()) \
    .rfmo.str.split('|', expand=True) \
```

```
    .stack() \
    .reset_index() \
    .rename(columns={0:'rfmo'}) \
    .loc[:, plot_data5.columns] \
    .groupby('rfmo')['id_loitering'] \
    .sum() \
    .reset_index() \
    .sort_values('id_loitering')
plot_data5['rfmo'] = plot_data5['rfmo'].str.replace(' ','')
plot_data5 = plot_data5 \
    .groupby('rfmo')['id_loitering'] \
    .sum() \
    .reset_index() \
    .sort_values('id_loitering')
```

[181]:
```
fig, ax = plt.subplots(figsize=(10, 6))
sns.barplot(data=plot_data5.iloc[-20:,:],
    x='rfmo',
    y='id_loitering',
    ax = ax,
    color=color)
ax.set_xticklabels(ax.get_xticklabels(), rotation=45,␣
 ↪horizontalalignment='right')
plt.title('Top 20 RFMOs for dark meet-ups')
plt.ylabel('Frequency')
plt.xlabel('RFMO')
plt.show()
```


Top 20 RFMOs for dark meet-ups
Frequency
250000
200000
150000
100000
50000
0
SRFC
SEAFDEC
SIOFA
CPPS
FFA
SPC
NPAFC
IOTC
NPFC
ICES
NASCO
CCSBT
IATTC
SPRFMO
NAMMCO
ICCAT
PICES
WCPFC
IWC
ACAP
RFMO

[ ]: