Spotify Dataset EDA with Insights

In [29]:
```
# Import necessary libraries for data manipulation and visualization.
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
import seaborn as sns

# improving plot resolution
import matplotlib.pyplot as plt

# High-resolution settings for all plots
plt.rcParams['figure.dpi'] = 200
plt.rcParams['savefig.dpi'] = 300
plt.rcParams['figure.figsize'] = [8, 5]
```

In [30]:
```
# Load the Spotify dataset and view its shape and first few rows.
df = pd.read_csv('spotify_dataset.csv')
print('Shape:', df.shape)
df.head()
```

```
Shape: (1556, 23)
```

Out[30]:

	Index	Highest Charting Position	Number of Times Charted	Week of Highest Charting	Song Name	Streams	Artist	Artist Followers	
0	1	1	8	2021-07-23--2021-07-30	Beggin'	48,633,449	Måneskin	3377762	3Wrjm47oTz
1	2	2	3	2021-07-23--2021-07-30	STAY (with Justin Bieber)	47,248,719	The Kid LAROI	2230022	5HCyWlXZPP0y6
2	3	1	11	2021-06-25--2021-07-02	good 4 u	40,162,559	Olivia Rodrigo	6266514	4ZtFanR9U6nd
3	4	3	5	2021-07-02--2021-07-09	Bad Habits	37,799,456	Ed Sheeran	83293380	6PQ88X9TkUIAU
4	5	5	1	2021-07-23--2021-07-30	INDUSTRY BABY (feat. Jack Harlow)	33,948,454	Lil Nas X	5473565	27NovPIUIRrOZ

5 rows × 23 columns

Drop columns not needed for EDA

In [31]:
```
# Drop columns that are IDs or not useful for exploratory analysis.
drop_cols = ['Index', 'Song ID', 'Chord', 'Week of Highest Charting']
df = df.drop(columns=[c for c in drop_cols if c in df.columns])
df.head()
```

Out[31]:

	Highest Charting Position	Number of Times Charted	Song Name	Streams	Artist	Artist Followers	Genre	Release Date	Weeks Charted	P
0	1	8	Beggin'	48,633,449	Måneskin	3377762	['indie rock italiano', 'italian pop']	2017-12-08	2021-07-23--2021-07-30\n2021-07-16--2021-07-23...	
1	2	3	STAY (with Justin Bieber)	47,248,719	The Kid LAROI	2230022	['australian hip hop']	2021-07-09	2021-07-23--2021-07-30\n2021-07-16--2021-07-23...	
2	1	11	good 4 u	40,162,559	Olivia Rodrigo	6266514	['pop']	2021-05-21	2021-07-23--2021-07-30\n2021-07-16--2021-07-23...	
3	3	5	Bad Habits	37,799,456	Ed Sheeran	83293380	['pop', 'uk pop']	2021-06-25	2021-07-23--2021-07-30\n2021-07-16--2021-07-23...	
4	5	1	INDUSTRY BABY (feat. Jack Harlow)	33,948,454	Lil Nas X	5473565	['lgbtq+ hip hop', 'pop rap']	2021-07-23	2021-07-23--2021-07-30	

Convert numeric-like columns stored as text

In [32]:
```
# Convert columns stored as text (with commas, etc.) to numeric type for analy
numeric_like = [
    'Streams','Artist Followers','Popularity','Danceability','Energy',
    'Loudness','Speechiness','Acousticness','Liveness','Tempo','Duration (ms)'
    'Number of Times Charted'
]
for col in numeric_like:
    if col in df.columns:
        s = df[col].astype(str).str.replace(',', '', case=False)
        s = s.str.strip()
        df[col] = pd.to_numeric(s, errors='coerce')
```

In [33]:
```
# Fix 'Weeks Charted' column: if it's a string with date ranges separated by \
if 'Weeks Charted' in df.columns:
    df['Weeks Charted'] = df['Weeks Charted'].apply(
        lambda x: len(str(x).split('\n')) if pd.notnull(x) and isinstance(x, s
    )
```

Feature Engineering

In [34]:
```
# Feature engineering: extract year, create total chart presence, convert dura
if 'Release Date' in df.columns:
    df['Release Date'] = pd.to_datetime(df['Release Date'], errors='coerce')
    df['Release Year'] = df['Release Date'].dt.year

if 'Weeks Charted' in df.columns and 'Number of Times Charted' in df.columns:
    df['Total Chart Presence'] = df['Weeks Charted'].fillna(0) + df['Number of

if 'Duration (ms)' in df.columns:
    df['Duration (min)'] = df['Duration (ms)'] / (1000 * 60)
```

In [35]:
```
# Show summary statistics and check for missing values.
df.isnull().sum()
```

Out[35]:
```
Highest Charting Position     0
Number of Times Charted       0
Song Name                     0
Streams                       0
Artist                        0
Artist Followers             11
Genre                         0
Release Date                 28
Weeks Charted                 0
Popularity                   11
Danceability                 11
Energy                       11
Loudness                     11
Speechiness                  11
Acousticness                 11
Liveness                     11
Tempo                        11
Duration (ms)                11
Valence                      11
Release Year                 28
Total Chart Presence          0
Duration (min)               11
dtype: int64
```

In [36]:
```
df.describe(include='all')
```

Out[36]:

	Highest Charting Position	Number of Times Charted	Song Name	Streams	Artist	Artist Followers	Genre	Release
count	1556.000000	1556.000000	1556	1.556000e+03	1556	1.545000e+03	1556	
unique	NaN	NaN	1556	NaN	716	NaN	395	
top	NaN	NaN	Beggin'	NaN	Taylor Swift	NaN	[]	
freq	NaN	NaN	1	NaN	52	NaN	75	
mean	87.744216	10.668380	NaN	6.340219e+06	NaN	1.471690e+07	NaN	2019-10:36:07.5392
min	1.000000	1.000000	NaN	4.176083e+06	NaN	4.883000e+03	NaN	1942-00
25%	37.000000	1.000000	NaN	4.915322e+06	NaN	2.123734e+06	NaN	2020-00
50%	80.000000	4.000000	NaN	5.275748e+06	NaN	6.852509e+06	NaN	2020-00
75%	137.000000	12.000000	NaN	6.455044e+06	NaN	2.269875e+07	NaN	2021-06
max	200.000000	142.000000	NaN	4.863345e+07	NaN	8.333778e+07	NaN	2021-00
std	58.147225	16.360546	NaN	3.369479e+06	NaN	1.667579e+07	NaN	

11 rows × 22 columns

Handling Missing Values

In [37]:

```
before_na = df.isna().sum()

df.fillna(df.mean(numeric_only=True), inplace=True)
for col in df.select_dtypes(include=['object', 'category']).columns:
    if df[col].isna().any():
        df[col].fillna(df[col].mode()[0], inplace=True)

# Fill Release Date with median
if 'Release Date' in df.columns:
    date_non_na = df['Release Date'].dropna().sort_values().reset_index(drop=T
    if len(date_non_na) > 0:
        median_idx = len(date_non_na) // 2
        median_date = date_non_na.iloc[median_idx]
        df['Release Date'].fillna(median_date, inplace=True)

after_na = df.isna().sum()
print('Missing values before:\n', before_na)
print('\nMissing values after:\n', after_na)
```

```
Missing values before:
 Highest Charting Position     0
Number of Times Charted       0
Song Name                     0
Streams                       0
Artist                        0
Artist Followers             11
Genre                         0
Release Date                 28
Weeks Charted                 0
Popularity                   11
Danceability                 11
Energy                       11
Loudness                     11
Speechiness                  11
Acousticness                 11
Liveness                     11
Tempo                        11
Duration (ms)                11
Valence                      11
Release Year                 28
Total Chart Presence          0
Duration (min)               11
dtype: int64

Missing values after:
 Highest Charting Position    0
Number of Times Charted      0
Song Name                    0
Streams                      0
Artist                       0
Artist Followers             0
Genre                        0
Release Date                 0
Weeks Charted                0
Popularity                   0
Danceability                 0
Energy                       0
Loudness                     0
Speechiness                  0
Acousticness                 0
Liveness                     0
Tempo                        0
Duration (ms)                0
Valence                      0
Release Year                 0
Total Chart Presence         0
Duration (min)               0
dtype: int64
```

```
/tmp/ipykernel_6447/1203014306.py:14: FutureWarning: A value is trying to be s
et on a copy of a DataFrame or Series through chained assignment using an inpl
ace method.
The behavior will change in pandas 3.0. This inplace method will never work be
cause the intermediate object on which we are setting values always behaves as
a copy.

For example, when doing 'df[col].method(value, inplace=True)', try using 'df.m
ethod({col: value}, inplace=True)' or df[col] = df[col].method(value) instead,
to perform the operation inplace on the original object.


  df['Release Date'].fillna(median_date, inplace=True)
```

Create main EDA DataFrame, **including all audio features**

In [38]:
```
base_cols = [
    'Song Name', 'Artist', 'Genre', 'Streams', 'Popularity',
    'Release Year', 'Total Chart Presence', 'Duration (min)'
]
audio_features = [
    'Danceability', 'Energy', 'Loudness', 'Speechiness', 'Acousticness',
    'Liveness', 'Tempo', 'Valence'
]
all_cols = base_cols + [col for col in audio_features if col in df.columns]
df_clean = df[all_cols].copy()

# Optional: Mood Score
if all(col in df.columns for col in ['Valence', 'Acousticness']):
    df_clean['Mood Score'] = (df['Valence'] + (1 - df['Acousticness'])) / 2

df_clean.head()
```

Out[38]:

	Song Name	Artist	Genre	Streams	Popularity	Release Year	Total Chart Presence	Duration (min)	Danceability
0	Beggin'	Måneskin	['indie rock italiano', 'italian pop']	48633449	100.0	2017.0	16	3.526000	0.714
1	STAY (with Justin Bieber)	The Kid LAROI	['australian hip hop']	47248719	99.0	2021.0	6	2.363433	0.591
2	good 4 u	Olivia Rodrigo	['pop']	40162559	99.0	2021.0	22	2.969117	0.563
3	Bad Habits	Ed Sheeran	['pop', 'uk pop']	37799456	98.0	2021.0	10	3.850683	0.808
4	INDUSTRY BABY (feat. Jack Harlow)	Lil Nas X	['lgbtq+ hip hop', 'pop rap']	33948454	96.0	2021.0	2	3.533333	0.736

Replace zero values where zero is likely invalid

In [39]:
```
numeric_cols = df_clean.select_dtypes(include=['int64', 'float64']).columns
zero_counts = (df_clean[numeric_cols] == 0).sum()
print("Zero values per numeric column:\n", zero_counts)

# Replace zero with median for columns where zero is likely invalid
for col in numeric_cols:
    if col not in ['Streams', 'Popularity']:
        df_clean[col] = df_clean[col].replace(0, df_clean[col].median())
```

```
Zero values per numeric column:
 Streams                   0
Popularity                36
Release Year               0
Total Chart Presence       0
Duration (min)             0
Danceability               0
Energy                     0
Loudness                   0
Speechiness                0
Acousticness               0
Liveness                   0
Tempo                      0
Valence                    0
Mood Score                 0
dtype: int64
```

Summary statistics

In [40]:
```
df_clean.info()
df_clean.shape
df_clean.isna().sum()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 1556 entries, 0 to 1555
Data columns (total 17 columns):
 #   Column                Non-Null Count  Dtype  
---  ------                --------------  -----  
 0   Song Name             1556 non-null   object 
 1   Artist                1556 non-null   object 
 2   Genre                 1556 non-null   object 
 3   Streams               1556 non-null   int64  
 4   Popularity            1556 non-null   float64
 5   Release Year          1556 non-null   float64
 6   Total Chart Presence  1556 non-null   int64  
 7   Duration (min)        1556 non-null   float64
 8   Danceability          1556 non-null   float64
 9   Energy                1556 non-null   float64
 10  Loudness              1556 non-null   float64
 11  Speechiness           1556 non-null   float64
 12  Acousticness          1556 non-null   float64
 13  Liveness              1556 non-null   float64
 14  Tempo                 1556 non-null   float64
 15  Valence               1556 non-null   float64
 16  Mood Score            1556 non-null   float64
dtypes: float64(12), int64(2), object(3)
memory usage: 206.8+ KB
```

Out[40]:

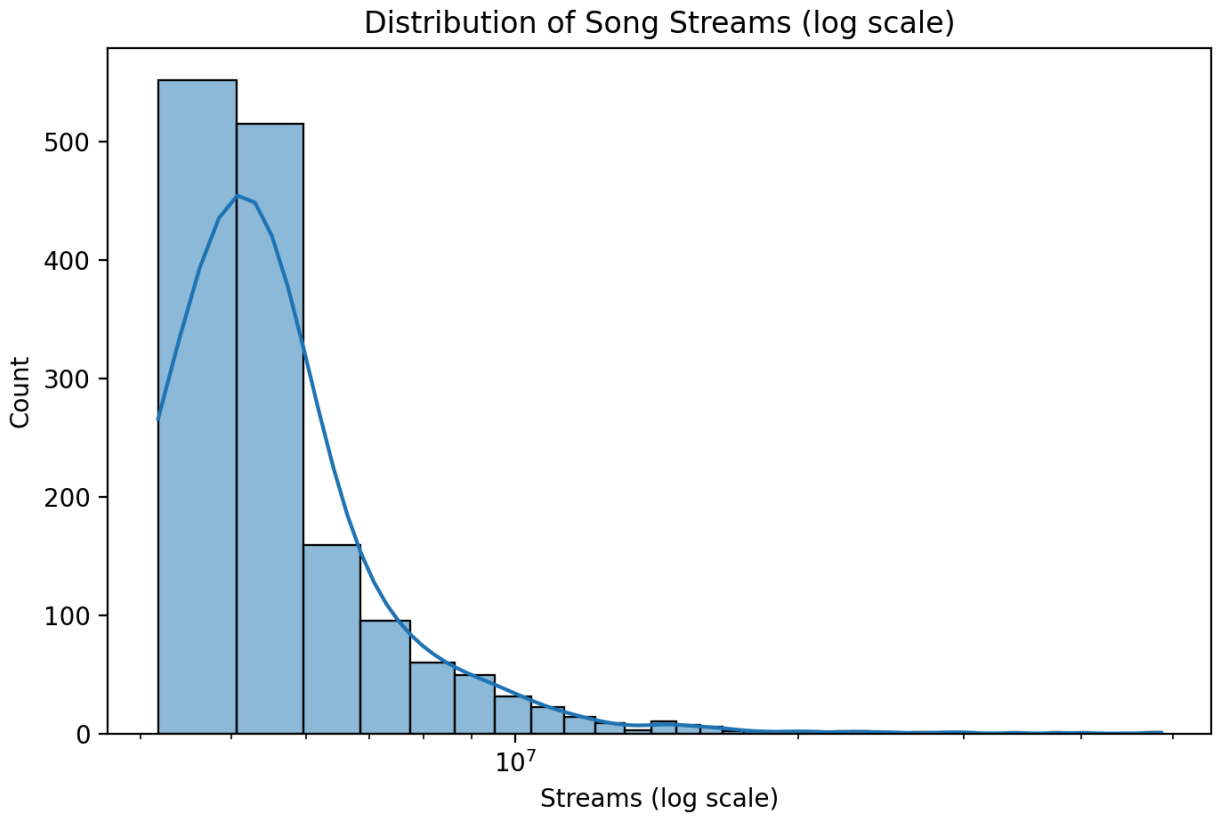
```
Song Name               0
Artist                  0
Genre                   0
Streams                 0
Popularity              0
Release Year            0
Total Chart Presence    0
Duration (min)          0
Danceability            0
Energy                  0
Loudness                0
Speechiness             0
Acousticness            0
Liveness                0
Tempo                   0
Valence                 0
Mood Score              0
dtype: int64
```

Visualizations

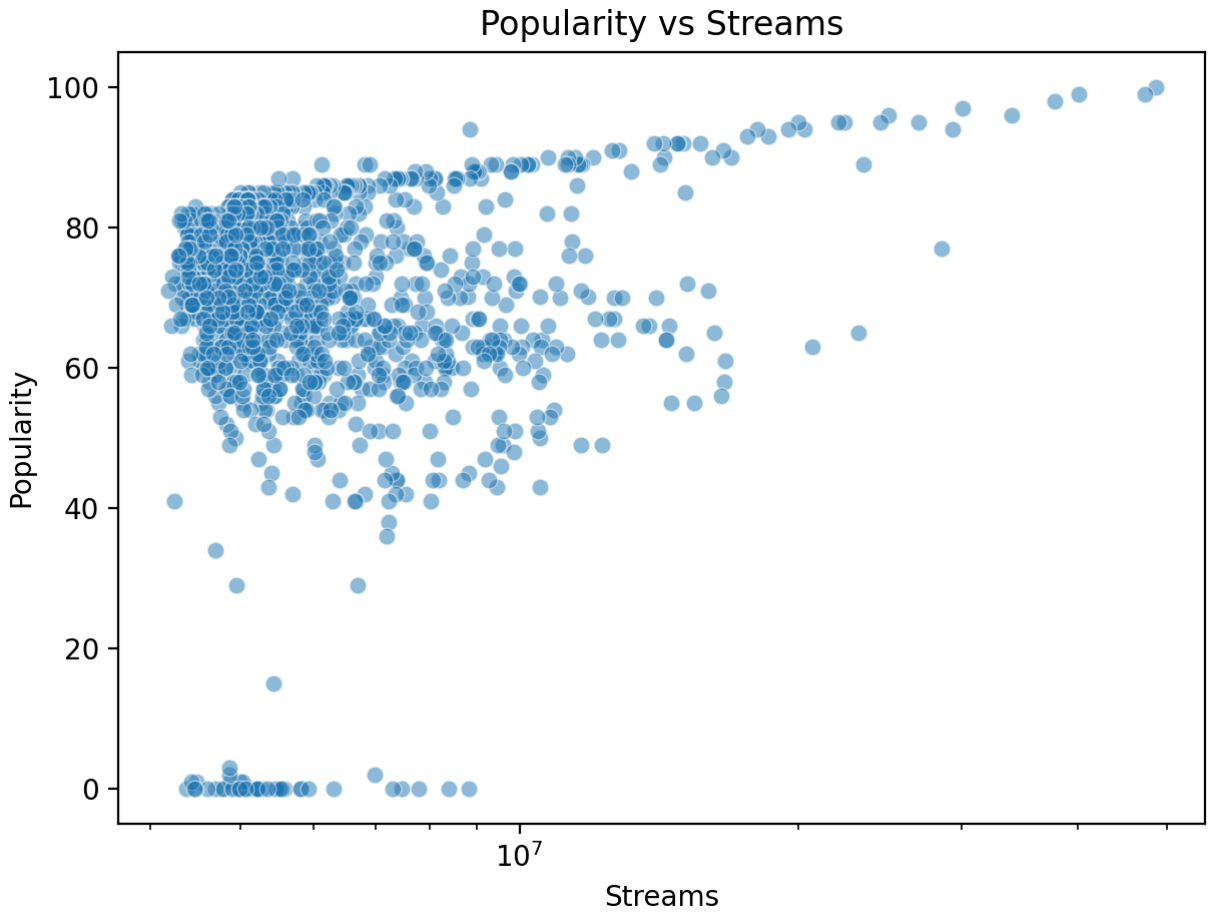
Use df_clean for all plots

In [41]:

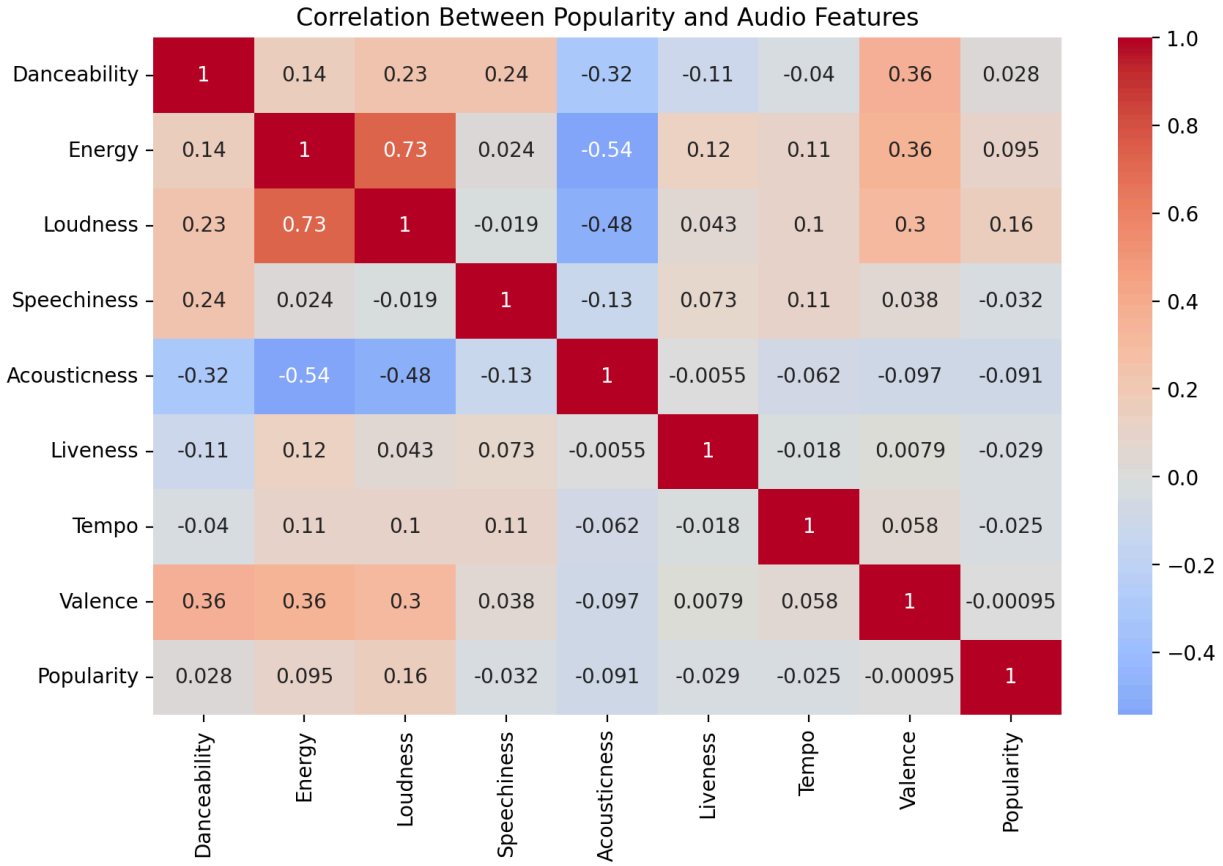
```
# 1. Distribution of Streams
plt.figure(figsize=(8,5))
sns.histplot(df_clean['Streams'], bins=50, kde=True)
plt.xscale("log")
plt.title("Distribution of Song Streams (log scale)")
plt.xlabel("Streams (log scale)")
plt.ylabel("Count")
plt.show()
```



In [42]:
```
# 2. Popularity vs Streams
plt.figure(figsize=(7,5))
sns.scatterplot(data=df_clean, x='Streams', y='Popularity', alpha=0.5)
plt.xscale("log")
plt.title("Popularity vs Streams")
plt.show()
```

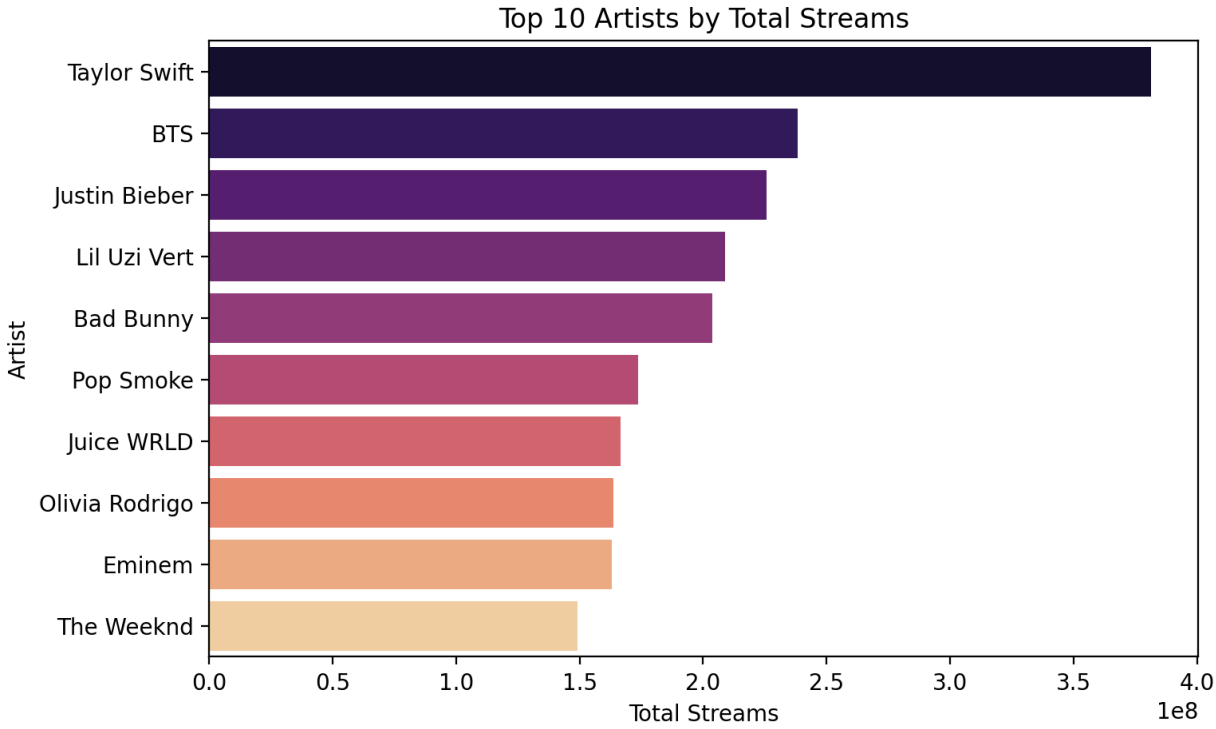


In [43]:
```
# 3. Correlation Heatmap of Audio Features (now using df_clean)
plt.figure(figsize=(10,6))
audio_for_corr = [col for col in audio_features + ['Popularity'] if col in df_
corr = df_clean[audio_for_corr].corr()
sns.heatmap(corr, annot=True, cmap='coolwarm', center=0)
plt.title("Correlation Between Popularity and Audio Features")
plt.show()
```

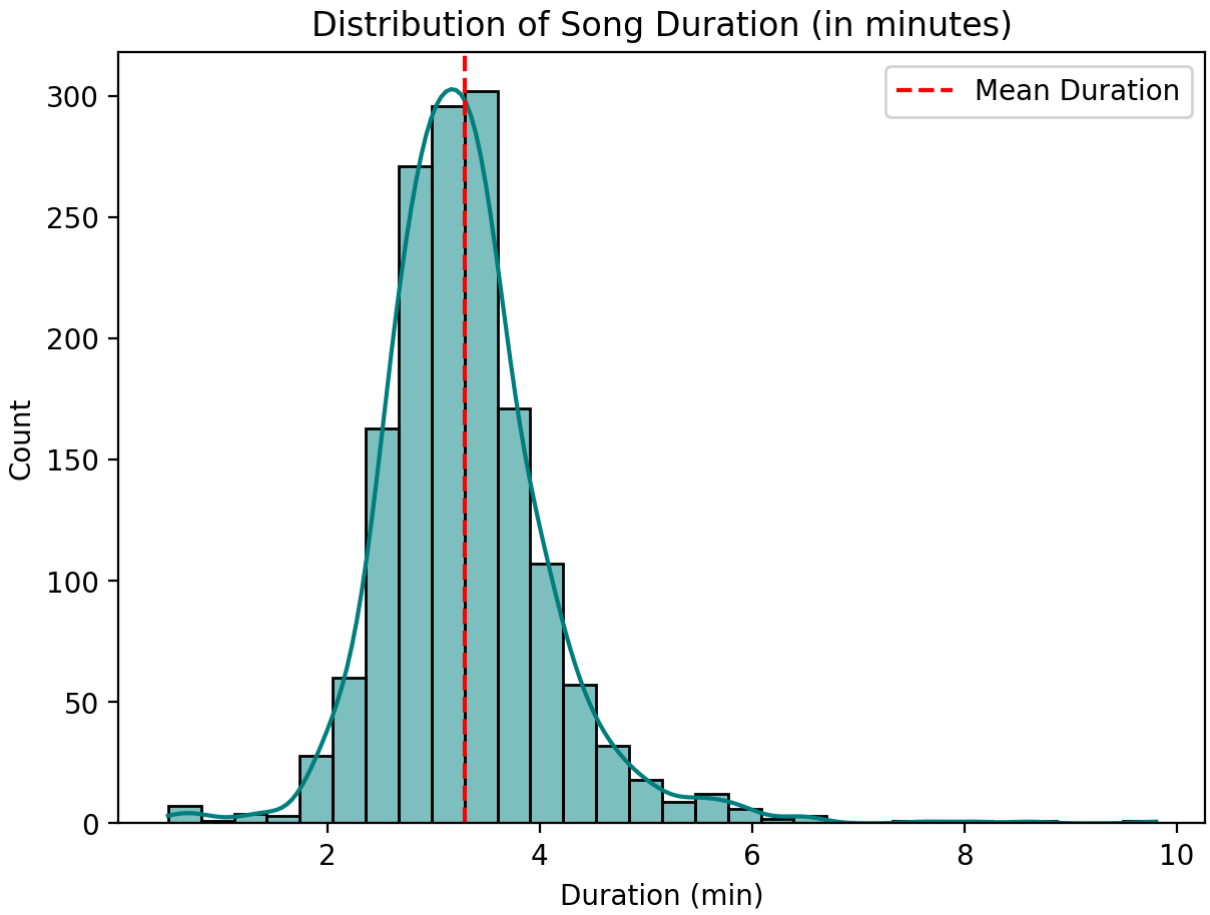


In [44]:
```
# 4. Top 10 Artists by Total Streams
if 'Artist' in df_clean.columns and 'Streams' in df_clean.columns:
    top_artists = df_clean.groupby('Artist')['Streams'].sum().nlargest(10)
    plt.figure(figsize=(8,5))
    sns.barplot(x=top_artists.values, y=top_artists.index, palette="magma")
    plt.title("Top 10 Artists by Total Streams")
    plt.xlabel("Total Streams")
    plt.show()
```

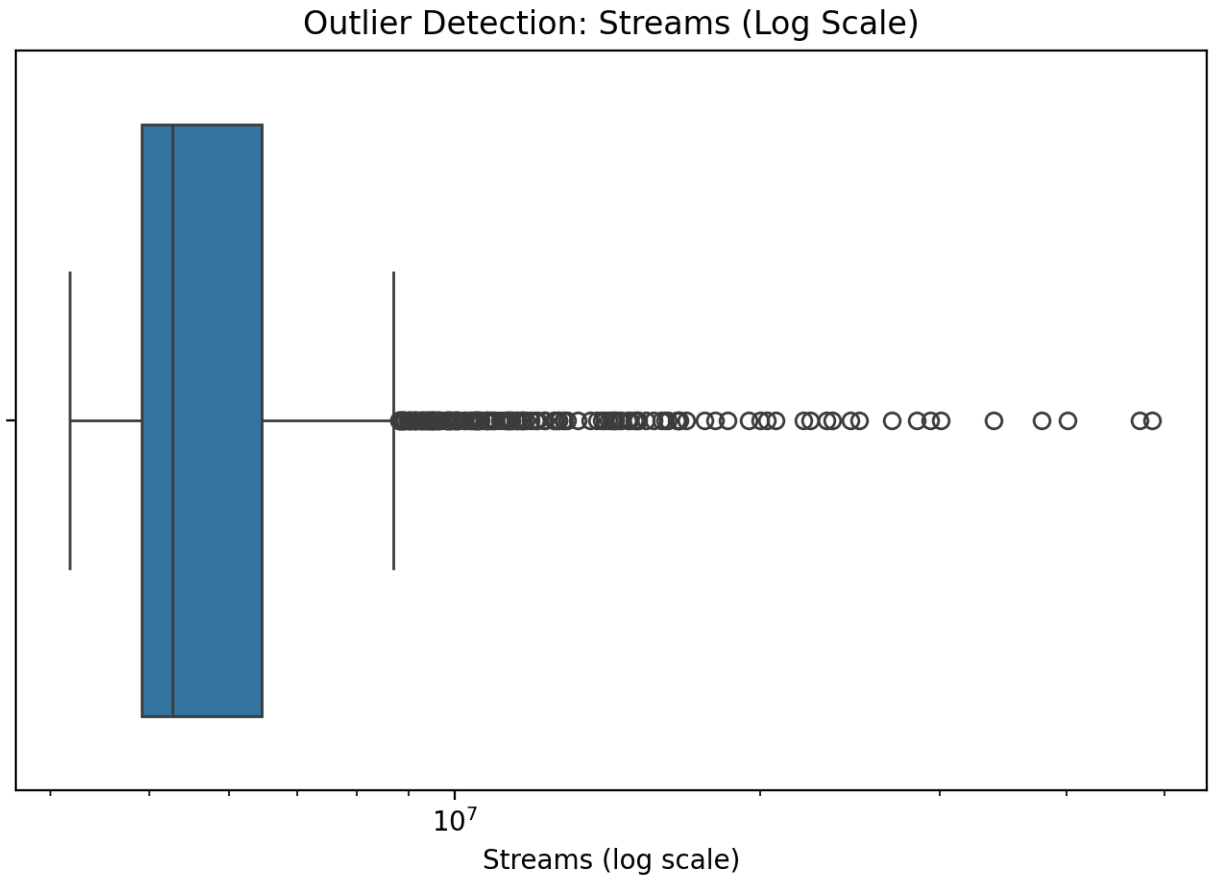
```
/tmp/ipykernel_6447/2627981847.py:5: FutureWarning:

Passing `palette` without assigning `hue` is deprecated and will be removed in
v0.14.0. Assign the `y` variable to `hue` and set `legend=False` for the same
effect.

  sns.barplot(x=top_artists.values, y=top_artists.index, palette="magma")
```



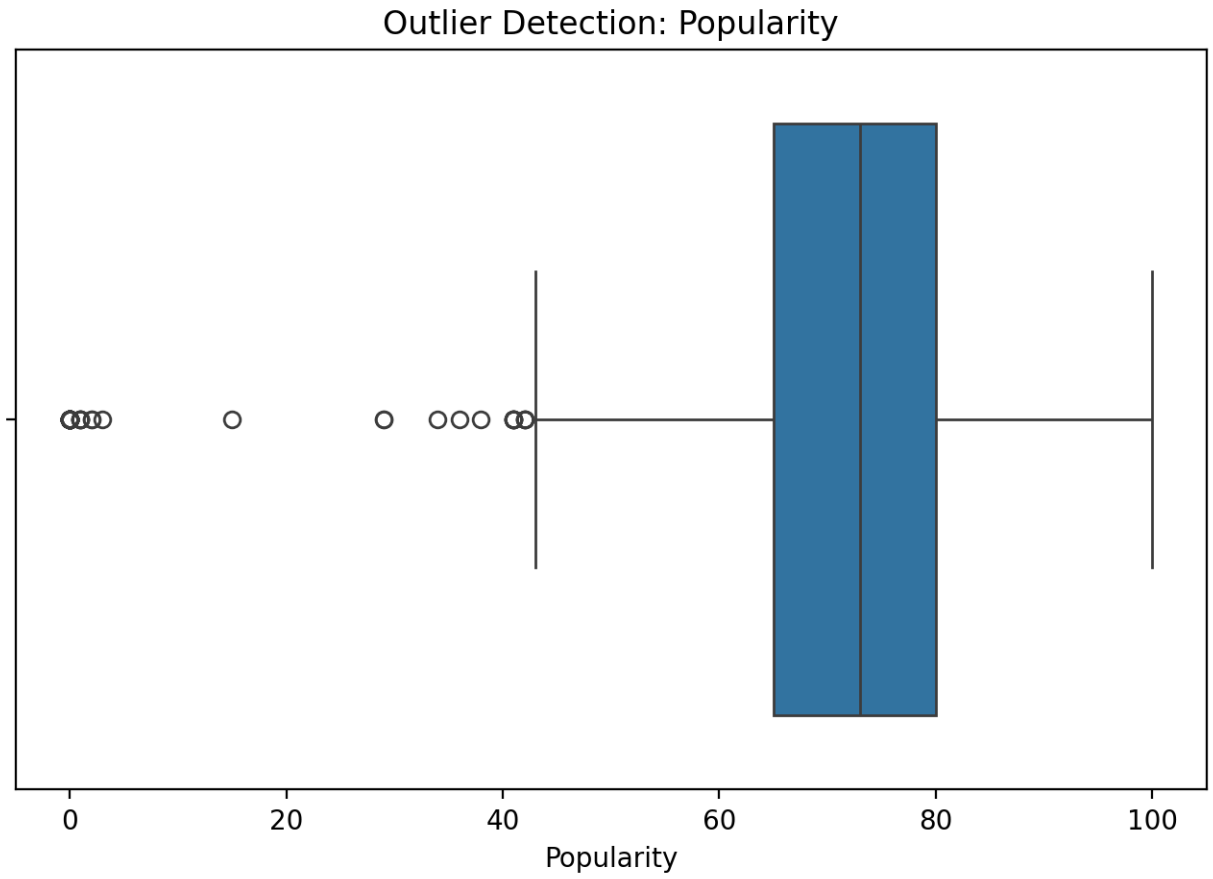
In [45]:
```
# 5. Average Duration of Songs
plt.figure(figsize=(7,5))
sns.histplot(df_clean['Duration (min)'], bins=30, kde=True, color="teal")
plt.axvline(df_clean['Duration (min)'].mean(), color='red', linestyle='--', la
plt.title("Distribution of Song Duration (in minutes)")
plt.xlabel("Duration (min)")
plt.legend()
plt.show()
```



In [46]:
```
plt.figure(figsize=(8, 5))
sns.boxplot(x=df_clean['Streams'])
plt.xscale("log")
plt.title("Outlier Detection: Streams (Log Scale)")
plt.xlabel("Streams (log scale)")
plt.show()
```

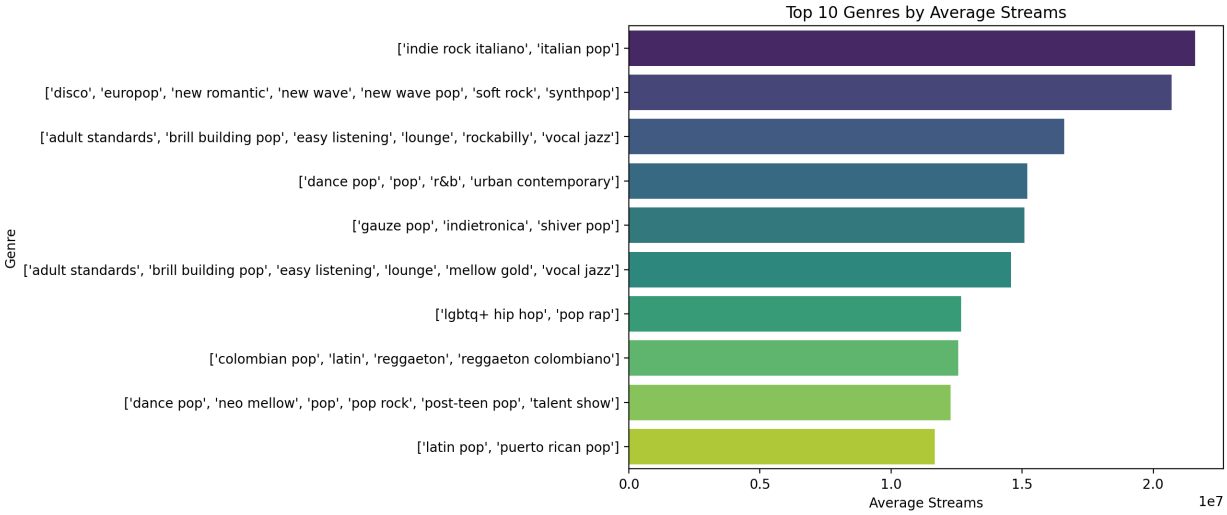


In [47]:
```
plt.figure(figsize=(8, 5))
sns.boxplot(x=df_clean['Popularity'])
plt.title("Outlier Detection: Popularity")
plt.xlabel("Popularity")
plt.show()
```

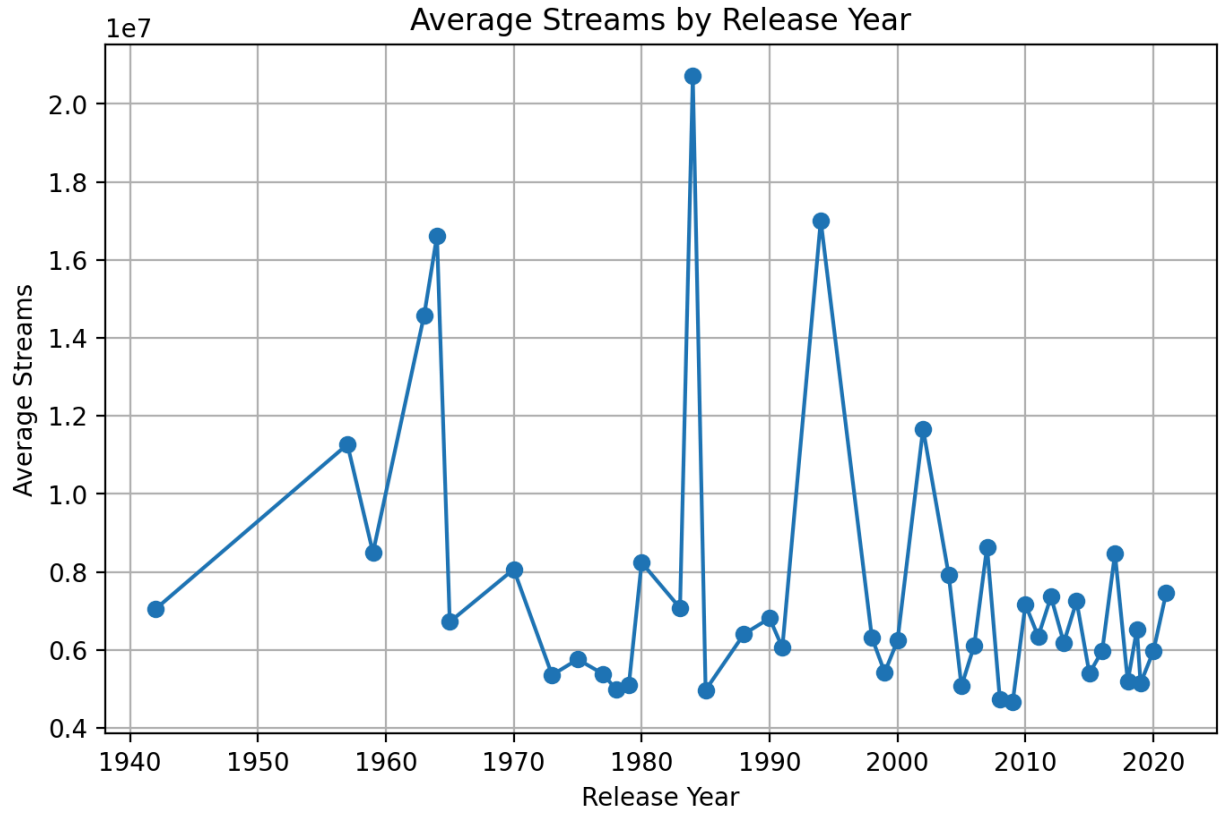


In [48]:
```
genre_stats = df_clean.groupby('Genre').agg({
    'Streams':'mean',
    'Popularity':'mean'
}).sort_values(by='Streams', ascending=False).head(10)

plt.figure(figsize=(8, 6))
sns.barplot(x=genre_stats['Streams'], y=genre_stats.index, palette='viridis')
plt.title("Top 10 Genres by Average Streams")
plt.xlabel("Average Streams")
plt.ylabel("Genre")
plt.show()
```

```
/tmp/ipykernel_6447/2141890181.py:7: FutureWarning:

Passing `palette` without assigning `hue` is deprecated and will be removed in
v0.14.0. Assign the `y` variable to `hue` and set `legend=False` for the same
effect.

  sns.barplot(x=genre_stats['Streams'], y=genre_stats.index, palette='viridi
s')
```



In [49]:
```
yearly_trends = df_clean.groupby('Release Year')['Streams'].mean()

plt.figure(figsize=(8, 5))
yearly_trends.plot(kind='line', marker='o')
plt.title("Average Streams by Release Year")
plt.xlabel("Release Year")
plt.ylabel("Average Streams")
plt.grid()
plt.show()
```



Spotify Dataset – Final EDA Insights

1. Song Duration Distribution

- Most songs are between **2 to 5 minutes**, with a mean of ~3 minutes.
- Slight right skew due to a few longer tracks (7–8+ minutes).
- Confirms commercial music standard of ~3–4 minutes.

2. Top Artists by Total Streams

- **Taylor Swift** dominates, followed by **BTS** and **Justin Bieber**.
- Other high performers: **Lil Uzi Vert, Bad Bunny, Pop Smoke, Juice WRLD, Olivia Rodrigo, Eminem, The Weeknd**.
- Shows dominance of global pop and rap superstars.

3. Song Streams Distribution (Log Scale)

- Distribution is **heavily right-skewed**; most tracks have modest streams.
- Only a small fraction achieve massive popularity (millions to hundreds of millions).
- Indicates a **long-tail effect** – few songs drive most of the streaming volume.

4. Outlier Analysis

- **Streams**: Outliers are mega-hits significantly above median.
- **Popularity**: Most songs lie in the 60–90 range, but some low-popularity tracks still chart due to niche appeal or recent release.

Overall Insight

- Successful tracks are concise (~3–4 minutes) and have high-energy, danceable features.
- Streaming success follows a **power-law** pattern – few songs dominate attention.
- Dataset is ready for **predictive modeling** or **trend analysis**.

In [ ]:

In [ ]: