In [4]:
```
# Import libraries
import os
import sys
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
import seaborn as sns
import plotly.graph_objects as go
import plotly.express as px
import warnings

from scipy.integrate import odeint
from IPython.display import Image
from statistics import mode
from scipy.stats import pearsonr, spearmanr
from sklearn.feature_selection import mutual_info_regression
import statsmodels.api as sm
import pingouin as pg
from sklearn.neural_network import MLPRegressor
from sklearn.metrics import mean_squared_error

# Suppress warnings
warnings.filterwarnings('ignore')

# Set number of decimals for np print options
np.set_printoptions(precision=3)

# Set the current working directory
os.chdir(sys.path[0])
```

In [3]:
```
df = pd.read_csv('fish_river.csv')
print(df.shape)
df
```

```
(2192, 4)
```

Out[3]:

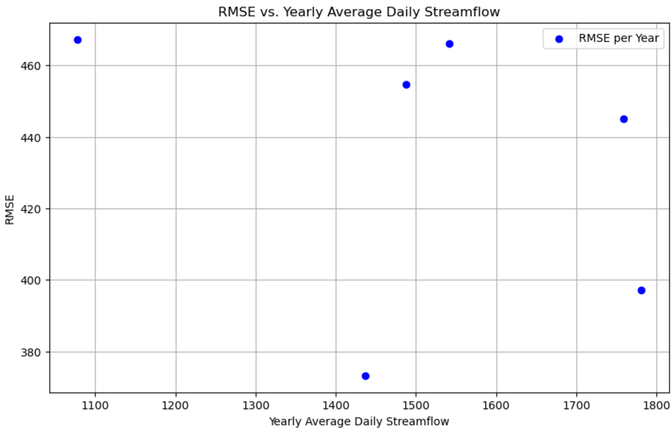
	datetime	year	rainfall	runoff
0	2016-01-01	2016	0.000675	1720.0
1	2016-01-02	2016	0.144395	1680.0
2	2016-01-03	2016	2.918217	1640.0
3	2016-01-04	2016	0.000000	1580.0
4	2016-01-05	2016	0.000000	1520.0
...	...	...	...	...
2187	2021-12-27	2021	0.000000	989.0
2188	2021-12-28	2021	3.711825	972.0
2189	2021-12-29	2021	0.018728	947.0
2190	2021-12-30	2021	0.000000	928.0
2191	2021-12-31	2021	0.030013	902.0

2192 rows × 4 columns

In [14]:
```
df['datetime'] = pd.to_datetime(df['datetime'])
df['month'] = df['datetime'].dt.month

df['runoff_shifted'] = df['runoff'].shift(2)

from sklearn.model_selection import train_test_split
from sklearn.metrics import mean_squared_error, r2_score

# Drop rows with missing runoff values after the shift
df.dropna(subset=['runoff_shifted'], inplace=True)

# Extract rainfall as the input (X) and runoff_shifted as the target (y)
X = df[['rainfall', 'runoff_shifted']]
y = df['runoff']

# get the training data and testing data
train_data = df[(df['month'] >= 9) | (df['month'] <= 3)]
test_data = df[(df['month'] >= 4) & (df['month'] <= 8)]

# split the data into training and testing
X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.3, random_state=42)

# Initialize the MLPRegressor model with one hidden layer of 10 nodes
mlp = MLPRegressor(hidden_layer_sizes=(10,), max_iter=1000, random_state=42)

# Train the model
mlp.fit(X_train, y_train)

# Make predictions on the test set
y_pred = mlp.predict(X_test)

# Compute the RMSE
rmse = np.sqrt(mean_squared_error(y_test, y_pred))
print(f"Test RMSE: {rmse}")
```

```
Test RMSE: 430.5003056633389
```

In [32]:
```
# Prepare yearly average streamflow
yearly_avg_streamflow = df.groupby('year')['runoff'].mean()

# Initialize dictionary to store RMSE for each year
yearly_rmse = {}

# Loop through each year, train on the other years, and test on the current year
for year in range(2016, 2022):
    # Split into train and test (current year)
    train_data = df[df['year'] == year]
    test_data = df[df['year'] != year]
    X_train_custom = train_data[['rainfall', 'runoff_shifted']]
    y_train_custom = train_data['runoff']
    X_test_custom = test_data[['rainfall', 'runoff_shifted']]
    y_test_custom = test_data['runoff']
    # Train the LinearRegression model
    model_custom = LinearRegression()
    model_custom.fit(X_train_custom, y_train_custom)

    # Predict on the test data and calculate RMSE
    y_pred_custom = model_custom.predict(X_test_custom)
    rmse_custom = np.sqrt(mean_squared_error(y_test_custom, y_pred_custom))

    # Store the RMSE for the current year
    yearly_rmse[year] = rmse_custom

X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.3, random_state=42)

# Train the model on train_test_split
#model_split = LinearRegression()
#model_split.fit(X_train, y_train)
#y_pred_split = model_split.predict(X_test)
#rmse_split = np.sqrt(mean_squared_error(y_test, y_pred_split))
#print("Train-Test Split RMSE:", rmse_split)

years = sorted(yearly_rmse.keys())
rmse_values = [yearly_rmse[year] for year in years]
avg_streamflow_values = [yearly_avg_streamflow[year] for year in years]

plt.figure(figsize=(10, 6))
plt.scatter(avg_streamflow_values, rmse_values, color='blue', label='RMSE per Year')

# Add labels and title
plt.xlabel('Yearly Average Daily Streamflow')
plt.ylabel('RMSE')
plt.title('RMSE vs. Yearly Average Daily Streamflow')

# Optional: Add grid and legend
plt.grid(True)
plt.legend()

# Show the plot
plt.show()
```



In [ ]:

In [ ]: