In [236]:
```
import pandas as pd
import jscatter
import matplotlib.pyplot as plt
import numpy as np
%matplotlib inline
```

In [237]:
```
def expectedLife(Fertility):
    return (86.098606 - 4.6620018 * Fertility)
```

In [238]:
```
df = pd.read_excel('Proj1DataMain.xlsx')
df.rename(columns = {'2019 Fertility':'2019_Fertility', '2019 Life Expectancy':'2019_Life_Expectancy'}, inplace = Tr
#fertCol = df['Fertility']
#lifeCol = df['2019 Life Expectancy']
df.insert(loc = 3, column ="Predicted_Life_Expectancy", value =0)
df['Predicted_Life_Expectancy'] = df['2019_Fertility'].apply(expectedLife)
df.head()
```

Out[238]:

	Country	2019_Fertility	2019_Life_Expectancy	Predicted_Life_Expectancy
0	Afghanistan	4.3	65.98	66.051998
1	Albania	1.6	78.96	78.639403
2	Algeria	3.0	77.50	72.112601
3	Angola	5.4	62.22	60.923796
4	Antigua and Barbuda	2.0	77.47	76.774602

Fertility graph skews right

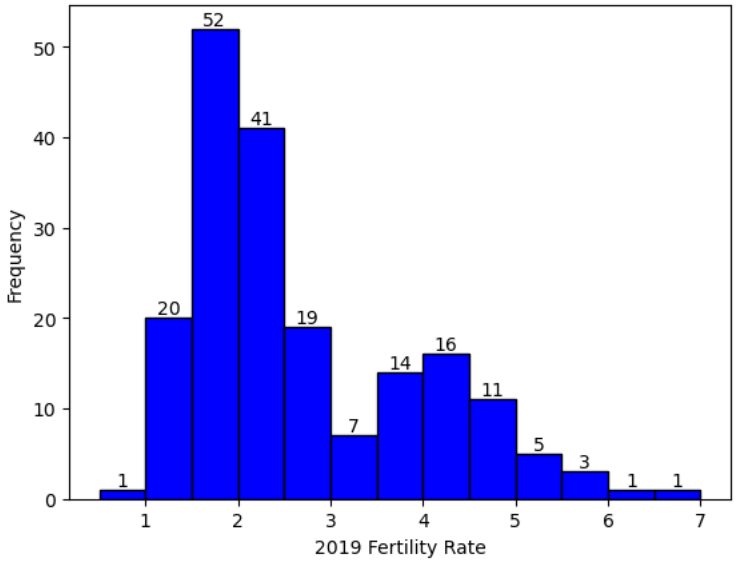
In [239]:
```
fertBins=[0.5, 1, 1.5, 2, 2.5, 3, 3.5, 4, 4.5, 5, 5.5, 6, 6.5, 7]

plt.xlabel('2019 Fertility Rate')
plt.ylabel('Frequency')

# Create the histogram
hist, edges, _ = plt.hist(fertCol, edgecolor='black', bins=fertBins, color = 'blue')

# Label each bin with its frequency
for count, (edge, freq) in enumerate(zip(edges[:-1], hist)):
    plt.text(edge + (edges[count + 1] - edge) / 2, freq, str(int(freq)), ha='center', va='bottom')

plt.show()
```



Life expectancy graph skews left

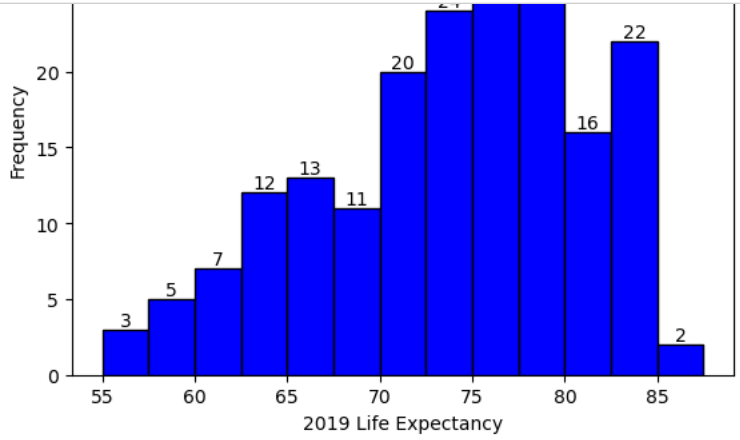
In [240]:
```
lifeBins=[55, 57.5, 60, 62.5, 65, 67.5, 70, 72.5, 75, 77.5, 80, 82.5, 85, 87.5]

plt.xlabel('2019 Life Expectancy')
plt.ylabel('Frequency')

# Create the histogram
hist, edges, _ = plt.hist(lifeCol, edgecolor='black', bins=lifeBins, color = 'blue')

# Label each bin with its frequency
for count, (edge, freq) in enumerate(zip(edges[:-1], hist)):
    plt.text(edge + (edges[count + 1] - edge) / 2, freq, str(int(freq)), ha='center', va='bottom')

plt.show()
```



In [241]:
```
print('Fertility: ')
print(f'mean: {df.iloc[:,1].mean()}')
print(f'variance: {df.iloc[:,1].var()}')
print(f'standard deviation: {df.iloc[:,1].std()}')
print(f'standard deviation: {df.iloc[:,1].median()}')
```

```
Fertility:
mean: 2.6362670157068067
variance: 1.5474940388536778
standard deviation: 1.243983134473164
standard deviation: 2.2
```

In [242]:
```
print('Life Expectancy: ')
print(f'mean: {df.iloc[:,2].mean()}')
print(f'variance: {df.iloc[:,2].var()}')
print(f'standard deviation: {df.iloc[:,2].std()}')
print(f'standard deviation: {df.iloc[:,2].median()}')
```

```
Life Expectancy:
mean: 73.80832460732984
variance: 50.68711296775971
standard deviation: 7.11948825181696
standard deviation: 75.01
```

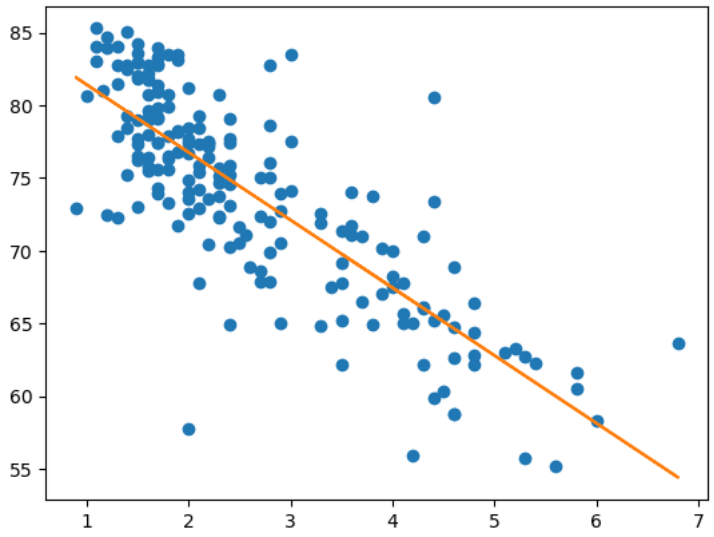
In 2019 the average global fertility rates and life expectancy were 2.64 and 73.81, respectively. The variance in fertility rates and life expectancy were 1.54 and 50.69 with a standard deviation of 1.23 and 7.12, respectively. This points to a fairly satisfied life expectancy considering the wide variance. The standard deviation suggests that most of the world fits within a 14 year gap of the average life expectancy.

In [243]:
```
plt.plot(df.iloc[:,1],df.iloc[:,2], 'o')

#obtain m (slope) and b(intercept) of linear regression line
m, b = np.polyfit(df.iloc[:,1],df.iloc[:,2], 1)

#add linear regression line to scatterplot
plt.plot(df.iloc[:,1], m*df.iloc[:,1]+b)
```

Out[243]:
```
[<matplotlib.lines.Line2D at 0x12db7f9d0>]
```



In [244]:
```
print('Sample size: ',len(df.iloc[:,1]))
print('Correlation coefficient: ', corr.iloc[:,1][0])
df.iloc[:,1:3].corr()
corr = df.iloc[:,1:3].corr()
print('R-squared: ', corr.iloc[:,1][0]**2)
```

```
Sample size:  191
Correlation coefficient:  -0.8145882605505986
R-squared:  0.66355403422685
```

The correlation coefficient of -0.81 demonstrates a strong negative linear correlation between fertility rate and life expectancy. That is to say, the higher the birthrate, the lower the life expectancy is on average. We can somewhat predict life expectancy with the formula Life Expectancy = 86.098606 - 4.6620018 x Fertility. The R2 = .6636, meaning that the 66.36% of the variance in life expectancy can be attributed to the fertility rate. This leaves room for other variables like access to healthcare to influence the variance in life expectancy.

The fertility and life expectancy of the United States is 1.7 and 79.11, respectively. Given the regression line, we would expect the US to have a life expectancy of 78.18. We calculate this with 86.098606 - 4.6620018 x US Fertility. Given the actual fertility rate of the US, the US has a longer life expectancy than predicted.

Some other countries that have the same fertility, and therefore the same predicted life expectancy are the UK, Sweden, New Zealand, Ireland, Costa Rica, China, and Brazil. Their actual life expectancy rates are as follows:

In [246]:
```
df.loc[df['2019_Fertility'] == 1.7].sort_values(by='2019_Life_Expectancy', ascending = False)
```

Out[246]:

	Country	2019_Fertility	2019_Life_Expectancy	Predicted_Life_Expectancy
8	Australia	1.7	83.94	78.173203
161	Sweden	1.7	83.33	78.173203
83	Ireland	1.7	82.81	78.173203
124	New Zealand	1.7	82.80	78.173203
46	Denmark	1.7	81.40	78.173203
40	Costa Rica	1.7	80.94	78.173203
45	Czech Rep.	1.7	79.85	78.173203
54	Estonia	1.7	79.18	78.173203
179	United States	1.7	79.11	78.173203
35	China	1.7	77.47	78.173203
116	Montenegro	1.7	77.39	78.173203
23	Brazil	1.7	75.57	78.173203
11	Bahamas	1.7	74.28	78.173203
171	Trinidad and Tobago	1.7	73.91	78.173203

Countries within ± 0.2 points of the US's fertility rate are Austria, Brunei, Colombia, France, Russia, and Trinidad and Tobago. Their actual and predicted life expectancies are as follows, respectively:

In [248]:
```
df.loc[(df['2019_Fertility'] < 2) & (df['2019_Fertility'] > 1.4)].sort_values(by='2019_Life_Expectancy', ascending =
```

Out[248]:

	Country	2019_Fertility	2019_Life_Expectancy	Predicted_Life_Expectancy
162	Switzerland	1.5	84.25	79.105603
8	Australia	1.7	83.94	78.173203
33	Channel Islands	1.5	83.60	79.105603
78	Iceland	1.8	83.52	77.707003
92	Korea, Dem. Rep.	1.9	83.50	77.240803
161	Sweden	1.7	83.33	78.173203
58	France	1.9	83.13	77.240803
30	Canada	1.5	82.96	79.105603
128	Norway	1.5	82.94	79.105603
83	Ireland	1.7	82.81	78.173203
124	New Zealand	1.7	82.80	78.173203
122	Netherlands	1.6	82.78	78.639403
16	Belgium	1.6	82.17	78.639403
9	Austria	1.5	82.05	79.105603
64	Germany	1.5	81.88	79.105603
152	Slovenia	1.6	81.85	78.639403
178	United Kingdom	1.6	81.77	78.639403
46	Denmark	1.7	81.40	78.173203
40	Costa Rica	1.7	80.94	78.173203
34	Chile	1.6	80.74	78.639403
139	Qatar	1.8	80.73	77.707003
108	Maldives	1.8	79.89	77.707003
45	Czech Rep.	1.7	79.85	78.173203
14	Barbados	1.6	79.64	78.639403
43	Cuba	1.6	79.18	78.639403
54	Estonia	1.7	79.18	78.173203
179	United States	1.7	79.11	78.173203
42	Croatia	1.5	79.02	79.105603
1	Albania	1.6	78.96	78.639403
60	French Polynesia	1.9	78.23	77.240803
123	New Caledonia	1.9	78.16	77.240803
151	Slovak Republic	1.6	78.00	78.639403
36	Colombia	1.8	77.87	77.707003
167	Thailand	1.5	77.74	79.105603
35	China	1.7	77.47	78.173203
116	Montenegro	1.7	77.39	78.173203
77	Hungary	1.5	77.31	79.105603
7	Aruba	1.9	76.79	77.240803
140	Romania	1.8	76.50	77.707003
147	Serbia	1.5	76.47	79.105603
101	Lithuania	1.6	76.41	78.639403
24	Brunei	1.8	76.35	77.707003
104	Macedonia, FYR	1.5	76.26	79.105603
97	Latvia	1.6	75.73	78.639403
23	Brazil	1.7	75.57	78.173203
6	Armenia	1.8	75.55	77.707003
25	Bulgaria	1.6	75.49	78.639403
11	Bahamas	1.7	74.28	78.173203
171	Trinidad and Tobago	1.7	73.91	78.173203
10	Azerbaijan	1.8	73.33	77.707003
141	Russia	1.5	72.99	79.105603
121	Nepal	1.9	71.75	77.240803

The Nordic countries, which often have the highest standard of living in the world, are as follow

In [249]:
```
df.loc[(df['Country'] == 'Norway') | (df['Country'] == 'Sweden')| (df['Country'] == 'Finland')| (df['Country'] == 'I
```

Out[249]:

	Country	2019_Fertility	2019_Life_Expectancy	Predicted_Life_Expectancy
46	Denmark	1.7	81.40	78.173203
57	Finland	1.4	82.48	79.571803
78	Iceland	1.8	83.52	77.707003
128	Norway	1.5	82.94	79.105603
161	Sweden	1.7	83.33	78.173203