Question One

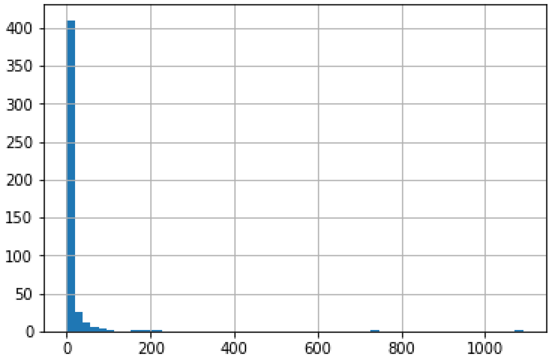
a)

As is displayed by the histogram below, the data is skewed to the left indicated the majority of the area being burned is little to none. There are minimal extreme cases where a large area of the forest is burned.

I reduced the amount of bins so the values were more easily observable.

In [5]:

```
num_bins = math.ceil(len(fire_df.area.unique())/4)
hist = fire_df.area.hist(bins=num_bins)
```



b)

In [6]:

```
%%capture
df_binary = fire_df.copy()
df_binary['area'] = fire_df.area.apply(lambda x: 0 if x == 0.0 else 1)
average_accuracy = k_fold_cross_validation(df_binary, 10)
```

In [7]:

```
average_accuracy
```

```
0.5043015726179464
```

Functions for Question One

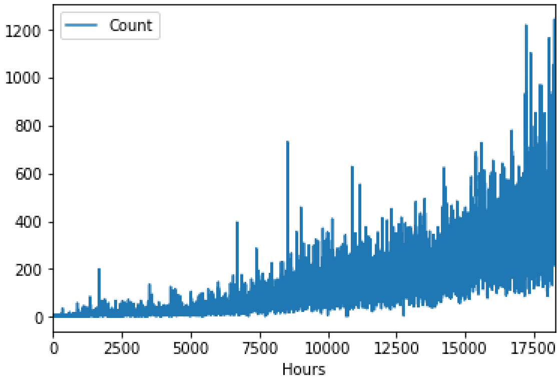
In [2]:

```
def k_fold(df, k):
    # randomly shuffle rows
    df = df.sample(frac=1).reset_index(drop=True)
    num_rows = df.shape[0]
    df['k_fold'] = np.repeat(np.nan, num_rows)
    num_extra_rows = num_rows % k
    if num_extra_rows != 0:
        num_rows_in_each_fold = math.floor(num_rows / k)
    else:
        num_rows_in_each_fold = num_rows / k
    if num_extra_rows > 0:
        last_slice = 0
        for fold in range(k):
            if fold < num_extra_rows:
                df.loc[fold * (num_rows_in_each_fold+1):(num_rows_in_each_fold+1)*(fold+
1),\
                       'k_fold'] = fold
                last_slice = (num_rows_in_each_fold+1)*(fold+1)
            else:
                df.loc[last_slice:last_slice+num_rows_in_each_fold, 'k_fold'] = fold
                last_slice = last_slice+num_rows_in_each_fold
        return df
    else:
        for fold in range(k):
            df.loc[fold * (num_rows_in_each_fold):(num_rows_in_each_fold)*(fold+1),\
                   'k_fold'] = fold
        return df



def k_fold_cross_validation(df, k):
    # Split data into k folds
    df_k_fold = k_fold(df_binary, 10)

    # Empty list to store k accuracies
    accuracies = []
    for fold in range(k):
        # Split into training and test sets
        test_df = df_k_fold[df_k_fold.k_fold == fold]
        test_df_label = test_df.area
        test_df = test_df.drop(['area'], axis=1)
        train_df = df_k_fold[df_k_fold.k_fold != fold]
        train_df_label = train_df.area
        train_df = train_df.drop(['area'], axis=1)

        # Create logistic model and use it to classify test set
        logistic_classifier = LogisticRegression(random_state=0, solver='lbfgs',
                                  multi_class='multinomial').fit(train_df, train_df_label
)
        accuracy = logistic_classifier.score(test_df, test_df_label)
        # Append accuracy of test set
        accuracies.append(accuracy)
    return sum(accuracies)/k
```

Question 2

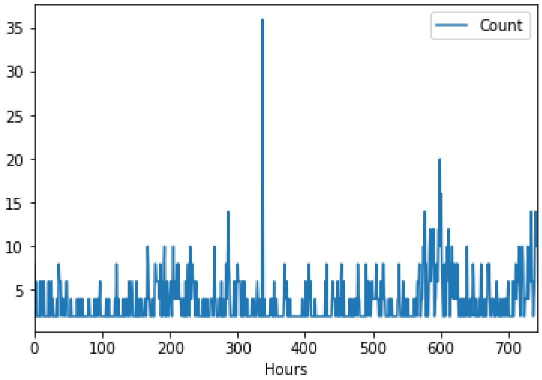
i)

```
In [9]: plot_ticket_data(tickets_df)
```



ii.a)

```
In [10]: plot_specific_data(tickets_df, '24-09-2012 23:00')
```



ii.b)

$$l(\lambda) = \prod_{n=1}^{N} \frac{e^{-\lambda}\lambda^{x_n}}{x_n!}$$

ii.c)

$$-log(\prod_{n=1}^{N} \frac{e^{-\lambda}\lambda^{x_n}}{x_n!}) =$$

$$-\sum_{n=1}^{N} log(\frac{e^{-\lambda}\lambda^{x_n}}{x_n!}) =$$

$$-\sum_{n=1}^{N}(log(e^{-\lambda}) + log(\lambda^{x_n}) - log(x_n!)) =$$

$$-\sum_{n=1}^{N}(-\lambda + x_n log(\lambda) - log(x_n!)) =$$

$$N\lambda + \sum_{n=1}^{N} log(x_n!) - log(\lambda)\sum_{n=1}^{N} x_n$$

ii.d)

$$\frac{d}{d\lambda}(N\lambda + \sum_{n=1}^{N} log(x_n!) - log(\lambda) \sum_{n=1}^{N} x_n) = 0$$

$$N - \frac{1}{\lambda} \sum_{n=1}^{N} x_n = 0$$

$$(N)^{-1} = (\frac{1}{\lambda} \sum_{n=1}^{N} x_n)^{-1}$$

$$\frac{1}{N} = \lambda \frac{1}{\sum_{n=1}^{N} x_n}$$

$$\lambda = \frac{1}{N} \sum_{n=1}^{N} x_n$$

ii.e)

```
In [11]: lambda_val = solve_lambda(tickets_df, '24-09-2012 23:00')

         lambda_val
```

```
3.7927321668909824
```

Functions for Question Two

In [8]:

```
def plot_ticket_data(df):
    count_row = df.shape[0]

    df_copy = df.copy()

    hours = list(range(count_row))
    hours_df = pd.DataFrame({"Hours":hours})

    df_copy = df_copy.join(hours_df)
    df_copy.plot(x='Hours', y='Count')


def plot_specific_data(df, cutoff_date):
    count_row = df.shape[0]

    df_copy = df.copy()

    hours = list(range(count_row))
    hours_df = pd.DataFrame({"Hours":hours})

    df_copy = df_copy.join(hours_df)

    my_index = int(df_copy.loc[df_copy['Datetime'] == cutoff_date].index[0])

    df_copy.iloc[0:my_index].plot(x='Hours', y='Count')


def solve_lambda(df, end_index):
    my_index = int(df.loc[df['Datetime'] == end_index].index[0])

    month_tickets_df = (df.loc[0:my_index])
    summation_count = 0
    for element in month_tickets_df['Count']:
        summation_count += element

    lambda_val = (1/my_index) * summation_count

    return lambda_val
```

In [1]:

```
import pandas as pd
import math
import numpy as np
from sklearn.linear_model import LogisticRegression

#Q1 data
fire_df = pd.read_csv('data.csv')
#Q2 data
tickets_df = pd.read_csv('question2-data.csv')
```

In [ ]: