In [151]:
```
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import statistics
import matplotlib.pyplot as plt
import pandas as pd
import seaborn as sns
import numpy as np
from mpl_toolkits.mplot3d import Axes3D
import statsmodels.formula.api as sm
from sklearn import cluster

%matplotlib inline
plot_kwds = {'alpha' : 0.25, 's' : 80, 'linewidths' : 0}
```

In [152]:
```
#appending letters for each bin

def createAPBin():
    binPA = []
    for x in df.AffectedPercentage:
        if x > 70:
            binPA.append('I')
        elif x > 60:
            binPA.append('H')
        elif x > 50:
            binPA.append('G')
        elif x > 40:
            binPA.append('F')
        elif x > 30:
            binPA.append('E')
        elif x > 20:
            binPA.append('D')
        elif x > 10:
            binPA.append('C')
        elif x > 0:
            binPA.append('B')
        else:
            binPA.append('A')
    return binPA

def plot_clusters(data, algorithm, args, kwds, xlabel = "x", ylabel = "y", nam
es = [], print_names = False):
    labels = algorithm(*args, **kwds).fit_predict(data)
    palette = sns.color_palette('deep', np.unique(labels).max() + 1)
    colors = [palette[x] if x >= 0 else (0.0, 0.0, 0.0) for x in labels]
    plt.scatter(data.T[0], data.T[1], c = colors, **plot_kwds)
    frame = plt.gca()
    plt.xlabel(xlabel)
    plt.ylabel(ylabel)
    plt.title('Clusters found by {}'.format(str(algorithm.__name__), fontsize=
24))

    if print_names:
        if len(names) != 0:
            for i, name in enumerate(names):
                plt.annotate(name, (data[i, 0], data[i, 1]))

def dictionary_sum(dictionary):
    total = 0
```

```
    for key in dictionary.keys():
        total += dictionary[key]

    return total
```

In [153]:
```
df = pd.read_csv("harvey.csv")

display(df.info())

df = df[df.PopTotal > 0]

df = df[df.Households > 0]

df = df[df.Occupied > 0]

df = df[df.PopTotal / df.Affected > 1]

df['AffectedPercentage'] = df.Affected / df.PopTotal * 100

# CREATING AFFECTED PERCENTAGE BIN
df['AffectedBin'] = createAPBin()

#MHI: stands for median household income

initialColumns = ['PopTotal', 'White', 'Black', 'Hispanic', 'Indian', 'Asian',
'NativeAmerican', 'Other', 'Mixed', 'Households', 'Occupied', 'MHI', 'Affecte
d', 'Children', 'Seniors', 'AffectedPercentage']

for i in initialColumns:
    print(i, 'Mean:', '%.3f'%(statistics.mean(df[i])) , 'St Dev: ','%.3f'%(sta
tistics.stdev(df[i])))
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 2539 entries, 0 to 2538
Data columns (total 25 columns):
State              2539 non-null int64
County             2539 non-null int64
Tract              2539 non-null int64
BLKGRP             2539 non-null int64
Geography          2539 non-null object
PopTotal           2539 non-null int64
White              2539 non-null int64
Black              2539 non-null int64
Hispanic           2539 non-null int64
Indian             2539 non-null int64
Asian              2539 non-null int64
NativeAmerican     2539 non-null int64
Other              2539 non-null int64
Mixed              2539 non-null int64
Households         2539 non-null int64
Unoccupied         2539 non-null int64
Occupied           2539 non-null int64
Vacant             2539 non-null int64
MHI                2539 non-null int64
Affected           2539 non-null int64
Children           2539 non-null int64
Seniors            2539 non-null int64
Count_Af_1         2539 non-null int64
Shape_Leng         2539 non-null float64

Shape_Area         2539 non-null float64
dtypes: float64(2), int64(22), object(1)
```

```
memory usage: 496.0+ KB

None

PopTotal Mean: 2173.390 St Dev:  1948.456
White Mean: 771.751 St Dev:  1063.206
Black Mean: 376.602 St Dev:  591.227
Hispanic Mean: 819.930 St Dev:  801.453
Indian Mean: 4.174 St Dev:  20.283
Asian Mean: 163.950 St Dev:  418.490
NativeAmerican Mean: 1.130 St Dev:  11.454
Other Mean: 4.418 St Dev:  22.407
Mixed Mean: 31.436 St Dev:  60.561
Households Mean: 740.909 St Dev:  596.813
Occupied Mean: 740.909 St Dev:  596.813
MHI Mean: 61698.796 St Dev:  39726.164
Affected Mean: 62.625 St Dev:  102.883
Children Mean: 166.782 St Dev:  205.438
Seniors Mean: 199.936 St Dev:  164.416
AffectedPercentage Mean: 4.340 St Dev:  7.593
```

In [154]:
```
popTotal = sum(df['PopTotal'])

popColumns = ['White', 'Black', 'Hispanic', 'Indian', 'Asian', 'NativeAmerica
n', 'Other', 'Mixed']

for i in popColumns:
    percentage = (sum(df[i]) / popTotal)
    percentage = '%.2f'%(float(percentage)*100)
    print(i, 'percentage:', percentage, '%')
```

```
White percentage: 35.51 %
Black percentage: 17.33 %
Hispanic percentage: 37.73 %
Indian percentage: 0.19 %
Asian percentage: 7.54 %
NativeAmerican percentage: 0.05 %
Other percentage: 0.20 %
Mixed percentage: 1.45 %
```

In [155]:
```
df[['PopTotal', 'Households', 'Unoccupied', 'Occupied', 'Vacant']].corr()
```

Out[155]:

	PopTotal	Households	Unoccupied	Occupied	Vacant
PopTotal	1.000000	0.956875	0.940517	0.956875	0.259328
Households	0.956875	1.000000	0.992090	1.000000	0.339835
Unoccupied	0.940517	0.992090	1.000000	0.992090	0.455203
Occupied	0.956875	1.000000	0.992090	1.000000	0.339835
Vacant	0.259328	0.339835	0.455203	0.339835	1.000000

In [156]:
```
df[['MHI', 'Affected', 'Households', 'Unoccupied', 'Occupied', 'Vacant']].corr
()
```

Out[156]:

	MHI	Affected	Households	Unoccupied	Occupied	Vacant
MHI	1.000000	-0.098142	0.184385	0.156466	0.184385	-0.135591
Affected	-0.098142	1.000000	-0.089817	-0.076428	-0.089817	0.064468

Households	0.184385	-0.089817	1.000000	0.992090	1.000000	0.339835
Unoccupied	0.156466	-0.076428	0.992090	1.000000	0.992090	0.455203
Occupied	0.184385	-0.089817	1.000000	0.992090	1.000000	0.339835
Vacant	-0.135591	0.064468	0.339835	0.455203	0.339835	1.000000

In [157]:
```
df[['White', 'MHI', 'Affected','Households', 'Unoccupied', 'Occupied', 'Vacant']].corr()
```

Out[157]:

	White	MHI	Affected	Households	Unoccupied	Occupied	Vacant
White	1.000000	0.453211	-0.190802	0.771011	0.750424	0.771011	0.153466
MHI	0.453211	1.000000	-0.098142	0.184385	0.156466	0.184385	-0.135591
Affected	-0.190802	-0.098142	1.000000	-0.089817	-0.076428	-0.089817	0.064468
Households	0.771011	0.184385	-0.089817	1.000000	0.992090	1.000000	0.339835
Unoccupied	0.750424	0.156466	-0.076428	0.992090	1.000000	0.992090	0.455203
Occupied	0.771011	0.184385	-0.089817	1.000000	0.992090	1.000000	0.339835
Vacant	0.153466	-0.135591	0.064468	0.339835	0.455203	0.339835	1.000000

In [158]:
```
df[['Black', 'MHI', 'Affected','Households', 'Unoccupied', 'Occupied', 'Vacant']].corr()
```

Out[158]:

	Black	MHI	Affected	Households	Unoccupied	Occupied	Vacant
Black	1.000000	-0.136720	0.145845	0.522868	0.526884	0.522868	0.238770
MHI	-0.136720	1.000000	-0.098142	0.184385	0.156466	0.184385	-0.135591
Affected	0.145845	-0.098142	1.000000	-0.089817	-0.076428	-0.089817	0.064468
Households	0.522868	0.184385	-0.089817	1.000000	0.992090	1.000000	0.339835
Unoccupied	0.526884	0.156466	-0.076428	0.992090	1.000000	0.992090	0.455203
Occupied	0.522868	0.184385	-0.089817	1.000000	0.992090	1.000000	0.339835
Vacant	0.238770	-0.135591	0.064468	0.339835	0.455203	0.339835	1.000000

In [159]:
```
df[['Hispanic', 'MHI', 'Affected','Households', 'Unoccupied', 'Occupied', 'Vacant']].corr()
```

Out[159]:

	Hispanic	MHI	Affected	Households	Unoccupied	Occupied	Vacant
Hispanic	1.000000	-0.232042	-0.018740	0.524969	0.518594	0.524969	0.161746
MHI	-0.232042	1.000000	-0.098142	0.184385	0.156466	0.184385	-0.135591
Affected	-0.018740	-0.098142	1.000000	-0.089817	-0.076428	-0.089817	0.064468
Households	0.524969	0.184385	-0.089817	1.000000	0.992090	1.000000	0.339835
Unoccupied	0.518594	0.156466	-0.076428	0.992090	1.000000	0.992090	0.455203
Occupied	0.524969	0.184385	-0.089817	1.000000	0.992090	1.000000	0.339835
Vacant	0.161746	-0.135591	0.064468	0.339835	0.455203	0.339835	1.000000

In [160]:
```
df[['Indian', 'MHI', 'Affected','Households', 'Unoccupied', 'Occupied', 'Vacant']].corr()
```

Out[160]:

	Indian	MHI	Affected	Households	Unoccupied	Occupied	Vacant
Indian	1.000000	0.048216	-0.055114	0.283762	0.276259	0.283762	0.057037
MHI	0.048216	1.000000	-0.098142	0.184385	0.156466	0.184385	-0.135591
Affected	-0.055114	-0.098142	1.000000	-0.089817	-0.076428	-0.089817	0.064468
Households	0.283762	0.184385	-0.089817	1.000000	0.992090	1.000000	0.339835
Unoccupied	0.276259	0.156466	-0.076428	0.992090	1.000000	0.992090	0.455203
Occupied	0.283762	0.184385	-0.089817	1.000000	0.992090	1.000000	0.339835
Vacant	0.057037	-0.135591	0.064468	0.339835	0.455203	0.339835	1.000000

In [161]:
```
df[['Asian', 'MHI', 'Affected','Households', 'Unoccupied', 'Occupied', 'Vacant']].corr()
```

Out[161]:

	Asian	MHI	Affected	Households	Unoccupied	Occupied	Vacant
Asian	1.000000	0.215121	-0.091156	0.650993	0.635739	0.650993	0.145518
MHI	0.215121	1.000000	-0.098142	0.184385	0.156466	0.184385	-0.135591
Affected	-0.091156	-0.098142	1.000000	-0.089817	-0.076428	-0.089817	0.064468
Households	0.650993	0.184385	-0.089817	1.000000	0.992090	1.000000	0.339835
Unoccupied	0.635739	0.156466	-0.076428	0.992090	1.000000	0.992090	0.455203
Occupied	0.650993	0.184385	-0.089817	1.000000	0.992090	1.000000	0.339835
Vacant	0.145518	-0.135591	0.064468	0.339835	0.455203	0.339835	1.000000

In [162]:
```
df[['NativeAmerican', 'MHI', 'Affected','Households', 'Unoccupied', 'Occupied', 'Vacant']].corr()
```

Out[162]:

	NativeAmerican	MHI	Affected	Households	Unoccupied	Occupied	Vacant
NativeAmerican	1.000000	0.005899	-0.021270	0.072154	0.070842	0.072154	0.018963
MHI	0.005899	1.000000	-0.098142	0.184385	0.156466	0.184385	-0.135591
Affected	-0.021270	-0.098142	1.000000	-0.089817	-0.076428	-0.089817	0.064468
Households	0.072154	0.184385	-0.089817	1.000000	0.992090	1.000000	0.339835
Unoccupied	0.070842	0.156466	-0.076428	0.992090	1.000000	0.992090	0.455203
Occupied	0.072154	0.184385	-0.089817	1.000000	0.992090	1.000000	0.339835
Vacant	0.018963	-0.135591	0.064468	0.339835	0.455203	0.339835	1.000000

In [163]:
```
df[['Other', 'MHI', 'Affected','Households', 'Unoccupied', 'Occupied', 'Vacant']].corr()
```

Out[163]:

	Other	MHI	Affected	Households	Unoccupied	Occupied	Vacant
Other	1.000000	0.070739	-0.034731	0.192849	0.190842	0.192849	0.061927
MHI	0.070739	1.000000	-0.098142	0.184385	0.156466	0.184385	-0.135591
Affected	-0.034731	-0.098142	1.000000	-0.089817	-0.076428	-0.089817	0.064468
Households	0.192849	0.184385	-0.089817	1.000000	0.992090	1.000000	0.339835
Unoccupied	0.190842	0.156466	-0.076428	0.992090	1.000000	0.992090	0.455203
Occupied	0.192849	0.184385	-0.089817	1.000000	0.992090	1.000000	0.339835

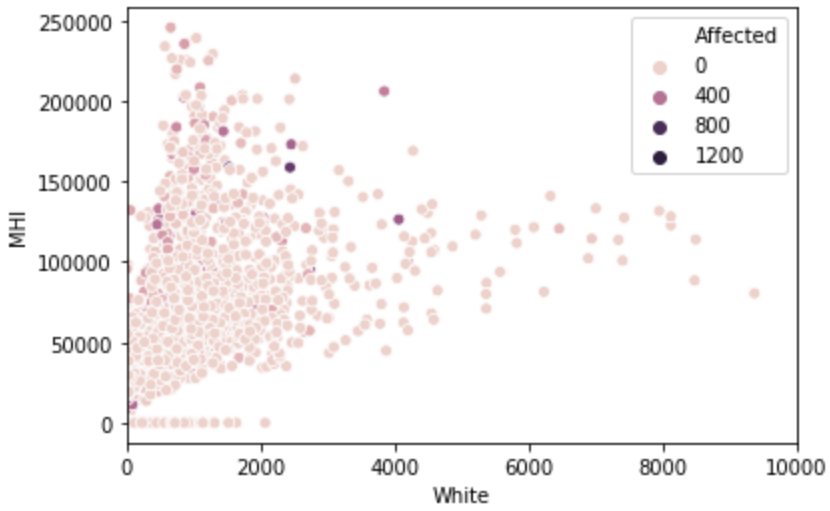
Vacant	0.061927	-0.135591	0.064468	0.339835	0.455203	0.339835	1.000000

In [164]:
```
df[['Mixed', 'MHI', 'Affected','Households', 'Unoccupied', 'Occupied', 'Vacant']].corr()
```

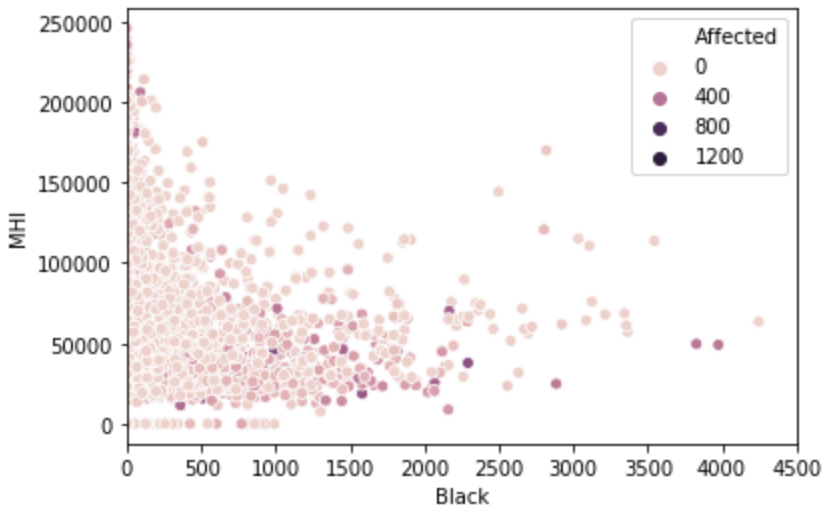
Out[164]:

	Mixed	MHI	Affected	Households	Unoccupied	Occupied	Vacant
Mixed	1.000000	0.189682	-0.107092	0.519732	0.508938	0.519732	0.126552
MHI	0.189682	1.000000	-0.098142	0.184385	0.156466	0.184385	-0.135591
Affected	-0.107092	-0.098142	1.000000	-0.089817	-0.076428	-0.089817	0.064468
Households	0.519732	0.184385	-0.089817	1.000000	0.992090	1.000000	0.339835
Unoccupied	0.508938	0.156466	-0.076428	0.992090	1.000000	0.992090	0.455203
Occupied	0.519732	0.184385	-0.089817	1.000000	0.992090	1.000000	0.339835
Vacant	0.126552	-0.135591	0.064468	0.339835	0.455203	0.339835	1.000000

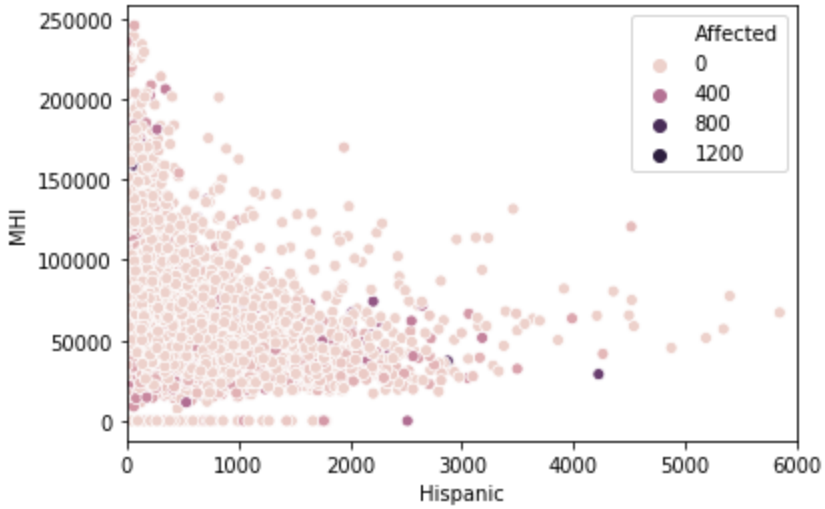
In [165]:
```
sns.scatterplot(x = 'White', y = 'MHI', data=df, hue='Affected')
plt.xlim(0, 10000)
plt.show()
```



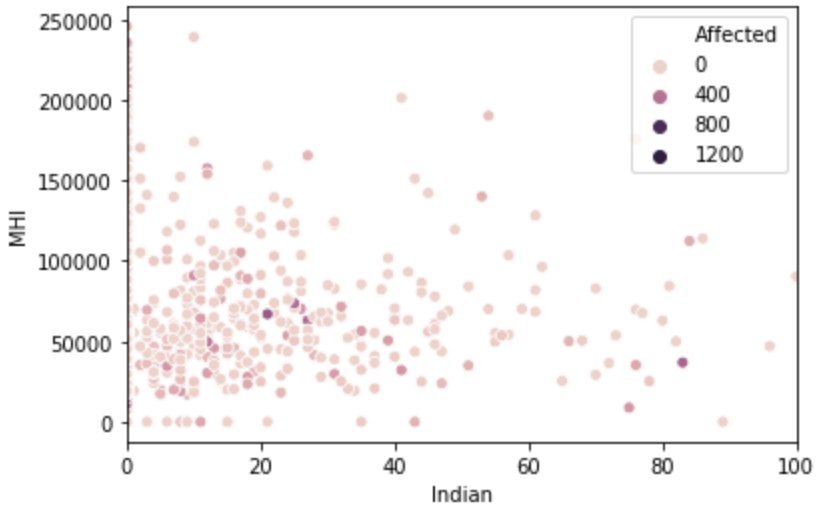
In [166]:
```
sns.scatterplot(x = 'Black', y = 'MHI', data=df, hue='Affected')
plt.xlim(0, 4500)
plt.show()
```



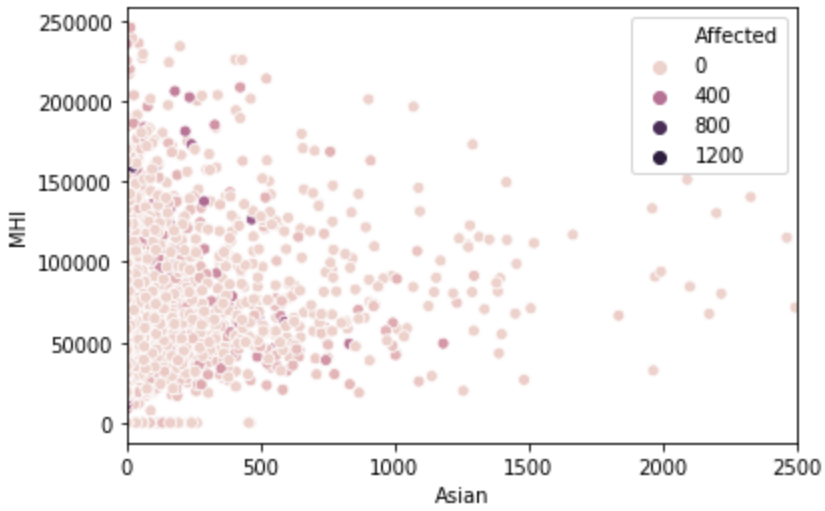
In [167]:
```
sns.scatterplot(x = 'Hispanic', y = 'MHI', data=df, hue='Affected')
plt.xlim(0, 6000)
plt.show()
```



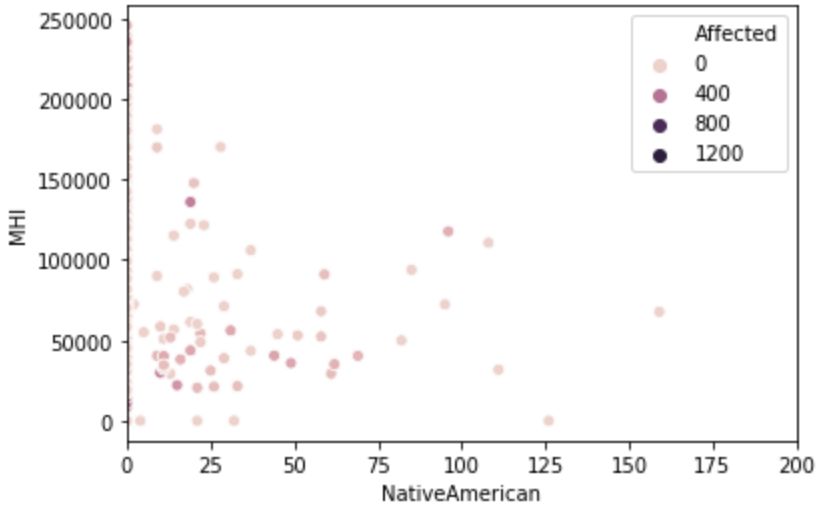
In [168]:
```
sns.scatterplot(x = 'Indian', y = 'MHI', data=df, hue='Affected')
plt.xlim(0, 100)
plt.show()
```



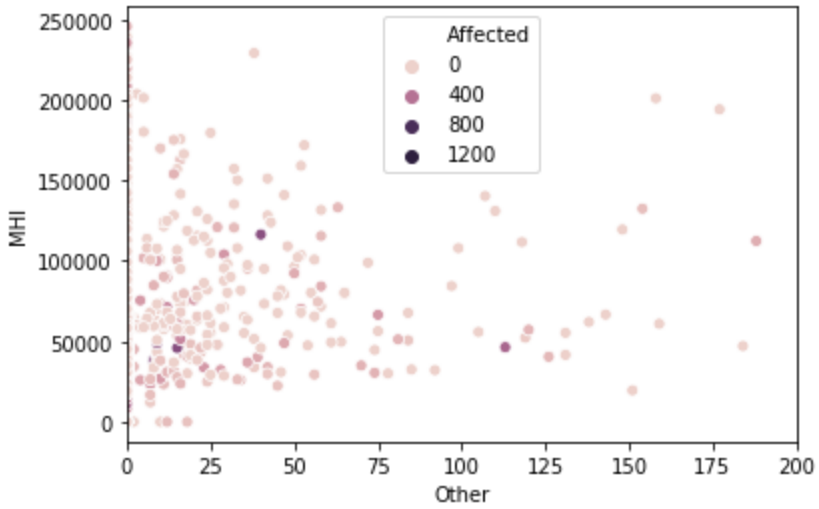
In [169]:
```
sns.scatterplot(x = 'Asian', y = 'MHI', data=df, hue='Affected')
plt.xlim(0, 2500)
plt.show()
```



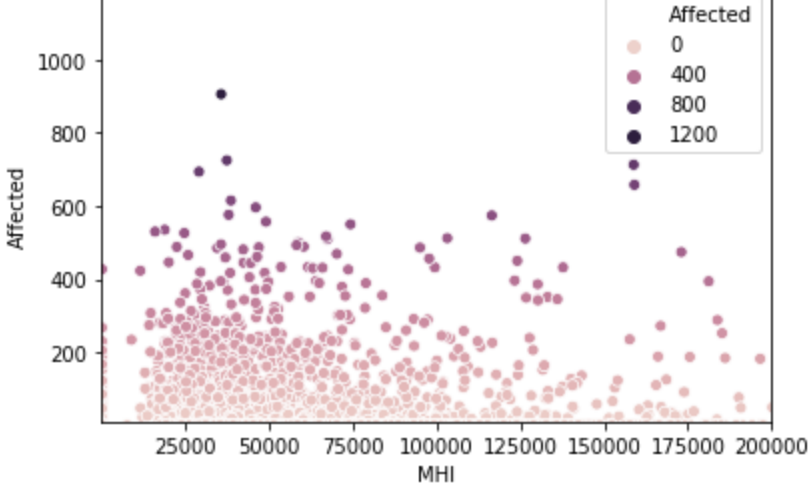
In [170]:
```
sns.scatterplot(x = 'NativeAmerican', y = 'MHI', data=df, hue='Affected')
plt.xlim(0, 200)
plt.show()
```



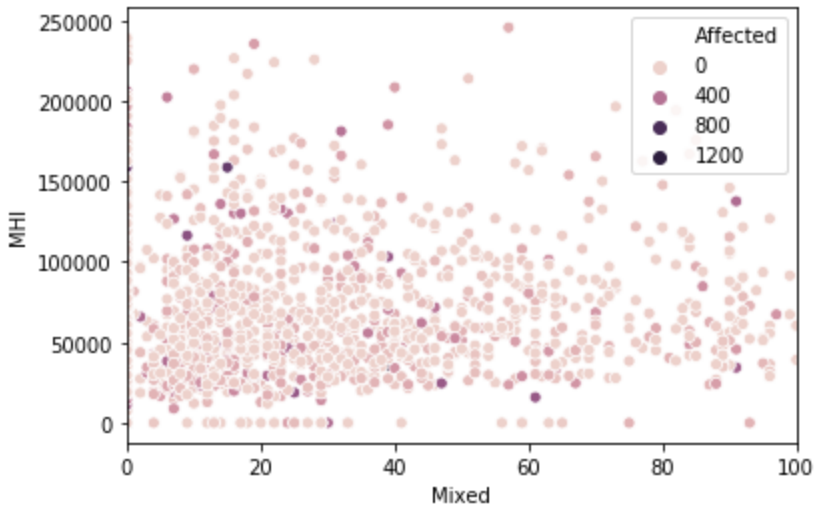
In [171]:
```
sns.scatterplot(x = 'Other', y = 'MHI', data=df, hue='Affected')
plt.xlim(0, 200)
plt.show()
```



In [172]:
```
sns.scatterplot(x = 'MHI', y = 'Affected', data=df, hue='Affected')
plt.xlim(10, 200000)
plt.ylim(10, 1200)
plt.show()
```



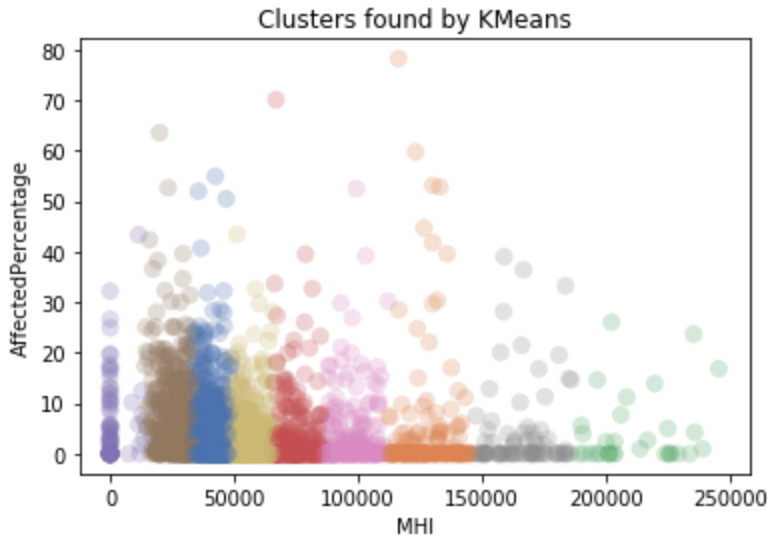
In [173]:
```
sns.scatterplot(x = 'Mixed', y = 'MHI', data=df, hue='Affected')
plt.xlim(0, 100)
plt.show()
```



In [174]:
```
data = df[['MHI', 'AffectedPercentage']].to_numpy()
binPA = list(df.AffectedBin)

plot_clusters(data, cluster.KMeans, (), {'n_clusters' : 9}, 'MHI', 'AffectedPe
rcentage', binPA)
labels = cluster.KMeans(n_clusters=9, random_state=0).fit(data)

# FIND AVERAGE MHI PER CLUSTER for groups in the cluster that were affected by
over 10 percent (remove A's and B's)

cluster_data = { 0 : {'total' : 0, 'total_mhi' : 0, 'total_affected_%' : 0}, 1
: {'total' : 0, 'total_mhi' : 0, 'total_affected_%' : 0}, 2 : {'total' : 0, 't
otal_mhi' : 0, 'total_affected_%' : 0}, 3 : {'total' : 0, 'total_mhi' : 0 , 't
otal_affected_%' : 0}, 4 : {'total' : 0, 'total_mhi' : 0, 'total_affected_%' :
0}, 5 : {'total' : 0, 'total_mhi' : 0, 'total_affected_%' : 0}, 6 : {'total' :
0, 'total_mhi' : 0, 'total_affected_%' : 0}, 7 : {'total' : 0, 'total_mhi' : 0
, 'total_affected_%' : 0}, 8 : {'total' : 0, 'total_mhi' : 0, 'total_affected
_%' : 0} }
cluster_counts = { 0: {}, 1 : {}, 2 : {}, 3 : {}, 4 : {}, 5 : {}, 6 : {}, 7 :
{}, 8 : {} }
for i in range(len(labels.labels_)):
    clust = labels.labels_[i]
    point_bin = binPA[i]
    if point_bin in cluster_counts[clust] :
        cluster_counts[clust][point_bin] += 1
```

```
        cluster_data[clust]['total'] += 1
        cluster_data[clust]['total_mhi'] += data[i][0]
        cluster_data[clust]['total_affected_%'] += data[i][1]
    else:
        cluster_counts[clust][point_bin] = 1

for clust in cluster_counts:
    cluster_data[clust]['average_mhi'] = cluster_data[clust]['total_mhi'] / cl
uster_data[clust]['total']
    print('Cluster {}: {}, Avg MHI: ${:,.2f}, Average Affected Percentage:
{:,.2f}%'.format(clust, {key : cluster_counts[clust][key] for key in sorted(cl
uster_counts[clust].keys())}, cluster_data[clust]['average_mhi'], cluster_data
[clust]['total_affected_%'] / cluster_data[clust]['total'] ))
```

```
Cluster 0: {'A': 201, 'B': 118, 'C': 20, 'D': 6, 'E': 3, 'I': 1}, Avg MHI:
$74,920.16, Average Affected Percentage: 2.37%
Cluster 1: {'A': 16, 'B': 10, 'C': 4, 'D': 2}, Avg MHI: $213,368.29, Average
Affected Percentage: 3.55%
Cluster 2: {'A': 101, 'B': 288, 'C': 92, 'D': 24, 'E': 7, 'F': 1, 'G': 1,
'H': 1}, Avg MHI: $26,213.50, Average Affected Percentage: 6.14%
Cluster 3: {'A': 109, 'B': 46, 'C': 5, 'D': 4, 'E': 2, 'F': 2, 'G': 3, 'I':
1}, Avg MHI: $127,536.88, Average Affected Percentage: 3.00%
Cluster 4: {'A': 269, 'B': 175, 'C': 39, 'D': 7, 'E': 1, 'F': 1}, Avg MHI:
$56,905.36, Average Affected Percentage: 2.71%
Cluster 5: {'A': 142, 'B': 77, 'C': 19, 'D': 3, 'E': 2, 'G': 1}, Avg MHI: $9
7,110.34, Average Affected Percentage: 2.70%
Cluster 6: {'A': 36, 'B': 28, 'C': 16, 'D': 2, 'E': 1, 'F': 1}, Avg MHI: $1,
173.36, Average Affected Percentage: 4.53%
Cluster 7: {'A': 45, 'B': 21, 'C': 7, 'D': 3, 'E': 3}, Avg MHI: $166,048.36,
Average Affected Percentage: 3.59%
Cluster 8: {'A': 208, 'B': 268, 'C': 69, 'D': 18, 'E': 2, 'F': 1, 'G': 3}, A
vg MHI: $40,753.49, Average Affected Percentage: 4.62%
```



In [175]:
```
#Parses out different values from our clusters

under_50k = 0
over_50k = 0
for clust in cluster_counts :
    print('Average MHI: ${:,.2f}, Total Affected: {}'.format(cluster_data[clus
t]['average_mhi'], dictionary_sum({ key if key != 'A' and key != 'B' else '' :
cluster_counts[clust][key] if key != 'A' and key != 'B' else 0 for key in clus
ter_counts[clust].keys()})))

    if cluster_data[clust]['average_mhi'] < 50000 :
        under_50k += dictionary_sum({ key if key != 'A' and key != 'B' else ''
: cluster_counts[clust][key] if key != 'A' and key != 'B' else 0 for key in cl
uster_counts[clust].keys()})
    else:
        over_50k += dictionary_sum({ key if key != 'A' and key != 'B' else ''
: cluster_counts[clust][key] if key != 'A' and key != 'B' else 0 for key in cl
uster_counts[clust].keys()})

print()

print('Under 50k groups affected by over 10% of population: {}'.format(under_5
0k))
print('Over 50k groups affected by over 10% of population: {}'.format(over_50k
))
```

```
Average MHI: $74,920.16, Total Affected: 30
Average MHI: $213,368.29, Total Affected: 6
Average MHI: $26,213.50, Total Affected: 126
Average MHI: $127,536.88, Total Affected: 17
Average MHI: $56,905.36, Total Affected: 48
Average MHI: $97,110.34, Total Affected: 25
Average MHI: $1,173.36, Total Affected: 20
Average MHI: $166,048.36, Total Affected: 13
Average MHI: $40,753.49, Total Affected: 93

Under 50k groups affected by over 10% of population: 239
Over 50k groups affected by over 10% of population: 139
```

In [176]:
```
#>10% Affected Population for Blocks $<50K MHI

239 / len(df.loc[df.MHI < 50000])*100
```

Out[176]: 19.96658312447786

In [177]:
```
#>10% Affected Population for Blocks $>50K MHI

139 / len(df.loc[df.MHI > 50000])*100
```

Out[177]: 10.388639760837071