In [61]:
```
from mpl_toolkits.mplot3d import Axes3D
#from sklearn.preprocessing import StandardScaler
import matplotlib.mlab as mlab
import matplotlib.pyplot as plt # plotting
import numpy as np # linear algebra
import os # accessing directory structure
import pandas as pd # data processing, CSV file I/O (e.g. pd.read_csv)
#import plotly.plotly as py
#import plotly.tools as tls
import seaborn as sns
#from statsmodels.tsa.stattools import adfuller
#from statsmodels.tsa.stattools import acf, pacf
#from statsmodels.graphics.tsaplots import plot_pacf,plot_acf
#from statsmodels.tsa.arima_model import ARIMA
#from pandas import DataFrame
#from sklearn.metrics import mean_squared_error
from math import sqrt
```

In [62]:
```
%matplotlib inline
```

In [63]:
```
Waves = pd.read_csv('Buoys-Waves.csv')
Control = pd.read_csv('control.csv')
```

In [64]:
```
Waves = Waves.rename(columns = {'Hs' : 'significant_wave_height' , 'Hmax' : 'm
aximum_wave_height', 'Tz' : 'zero_wave_period',
                        'Tp' : 'peak_wave_period' , 'SST' : 'sea_surface_temper
ature' , 'Peak Direction' : 'peak_direction'})
```

In [65]:
```
print(Waves.head())
#https://www.somacon.com/p570.php
Control.head()
```

```
       Date/Time  significant_wave_height  maximum_wave_height  \
0  1/1/2017 0:00                  -99.900               -99.90
1  1/1/2017 0:30                    0.875                 1.39
2  1/1/2017 1:00                    0.763                 1.15
3  1/1/2017 1:30                    0.770                 1.41
4  1/1/2017 2:00                    0.747                 1.16

   zero_wave_period  peak_wave_period  peak_direction  sea_surface_temperatur
e
0           -99.900           -99.900           -99.9                   -99.9
0
1             4.421             4.506           -99.9                   -99.9
0
2             4.520             5.513            49.0                    25.6
5
3             4.582             5.647            75.0                    25.5
0
4             4.515             5.083            91.0                    25.4
5
```

Out[65]:

	Species Name	Species Code	Date	Area	Location	Latitude	Longitude	
0	BULL WHALER	37018021.0	8/4/2017	Bribie Island	Woorim (Bribie Island)	-27.06835189	153.2113376	De
1	TIGER SHARK	37018022.0	8/8/2017	Bribie Island	Woorim (Bribie Island)	27.06511	153.2108	Eu
2	BULL WHALER	37018021.0	3/3/2017	Bundaberg	Neilson Park	-24.80429012	152.4641092	De
3	BULL WHALER	37018021.0	3/3/2017	Bundaberg	Kellys Beach	-24.83788865	152.4673179	De
4	BULL WHALER	37018021.0	17/03/2017	Bundaberg	Neilson Park	-24.80864323	152.4327342	De

In [66]:
```
# Variable meanings in the wave datset
# Date/Time - Date
#Hs -Significant wave height, an average of the highest third of the waves in
 a record
#Hmax -The maximum wave height in the record
#Tz- The zero upcrossing wave period
#Tp- The peak energy wave period
#Peak Direction -Direction (related to true north) from which the peak period
 waves are coming from
#SST -Approximation of sea surface temperature
```

In [67]:
```
print (len(Control))
print (len(Waves))
```

```
511
43728
```

Problem Statement and Background

Problem Statement and Background

Using data collected by buoys on oceanic wave patterns over a 30-month period, we will be looking at data dealing with wave height, energy, frequency, temperature, etc. during half hour intervals and attempting to find interactions between these columns, as well as plotting and predicting the wave pattern in the future given certain parameters base on the collected data. These are our main goals going into the research. To find interactions between data columns, if any exist (ex. Peak wave height and average wave height).Using the location and direction of the wave currents, being able to plot the patterns of the waves. Plot the patterns of ocean currents throughout a calendar year. Predict information about future wave patterns given a set of parameters such as time of year or ocean temperature. After analyzing what time and temperatures occur with the waves, it would be in our best interest if we could also investigate if they are related to the time and temperature that sharks often would attack. If there, is a relationship

between shark attacks to wave occurrence we can see when it is safe to surf as well as should

surfing not even be an option during certain times of the day / seasons. We know that shark attacks

are not predictable so far because almost all beaches have shark nets for protection.

So almost all shark attacks are random. We plan to use our data to see if these attacks

are more than random occurrences

Data Sources

The Data Source(s) You Intend to Use

https://www.kaggle.com/jolasa/waves-measuring-buoys-data-mooloolaba (https://www.kaggle.com/jolasa/waves-measuring-buoys-data-mooloolaba) https://www.data.qld.gov.au/dataset/coastal-data-system-waves-mooloolaba (https://www.data.qld.gov.au/dataset/coastal-data-system-waves-mooloolaba)

We found two datasets from kaggle that would be very beneficial for our project. The first dataset has 24000 rows and 6 columns. While the second dataset has 511 rows and 11 columns . I plan to collect more data as the project goes on because the more the better. For now, I have enough data to be satisfied for a quality project. I plan to join both datasets into one but it will take some time to figure out. The first dataset is stored in the Waves data frame in codio in the file (WavesCode) and the second dataset is stored in the “Control” data frame in the file (WavesCode). There is many data to work with so it should come out very clean and consistent.

Data Flaws/Weaknesses and Cleaning ¶

Data Flaws/Weaknesses and Cleaning

I was able to successfully join the two datasets. Any errors I did have in my data I either manually fixed or wrote a function that would clean it.

In [68]:
```
#cleaning up the data
#Waves = Waves.rename(columns = {'Hs' : 'significant_wave_height' , 'Hmax' :
 'maximum_wave_height', 'Tz' : 'zero_wave_period',
#'Tp' : 'peak_wave_period' , 'SST' : 'sea_surface_temperature' , 'Peak Directi
on' : 'peak_direction'})
Waves=Waves.replace(-99.9,np.nan)
Waves=Waves.interpolate(limit_direction='both')
Waves.head()
```

Out[68]:

	Date/Time	significant_wave_height	maximum_wave_height	zero_wave_period	peak_
0	1/1/2017 0:00	0.875	1.39	4.421	4.506
1	1/1/2017 0:30	0.875	1.39	4.421	4.506
2	1/1/2017 1:00	0.763	1.15	4.520	5.513
3	1/1/2017 1:30	0.770	1.41	4.582	5.647
4	1/1/2017 2:00	0.747	1.16	4.515	5.083

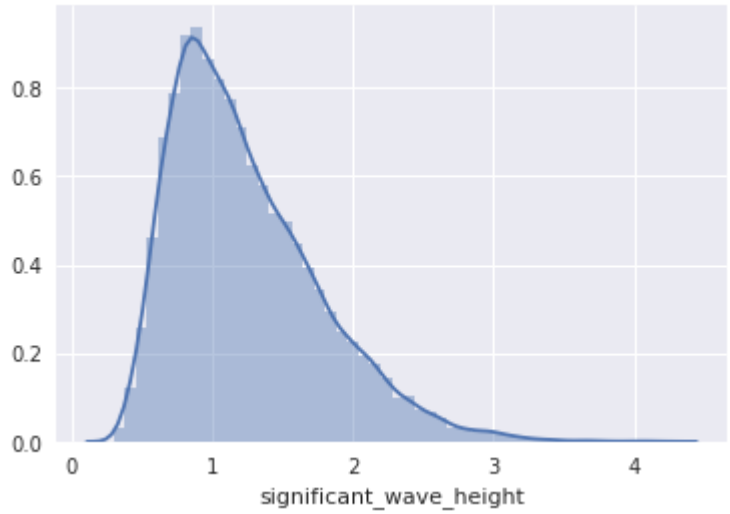
Basic Data Characteristics

Basic Data Characteristics In my codio file I was able to look more into these types of graphs and display them better.

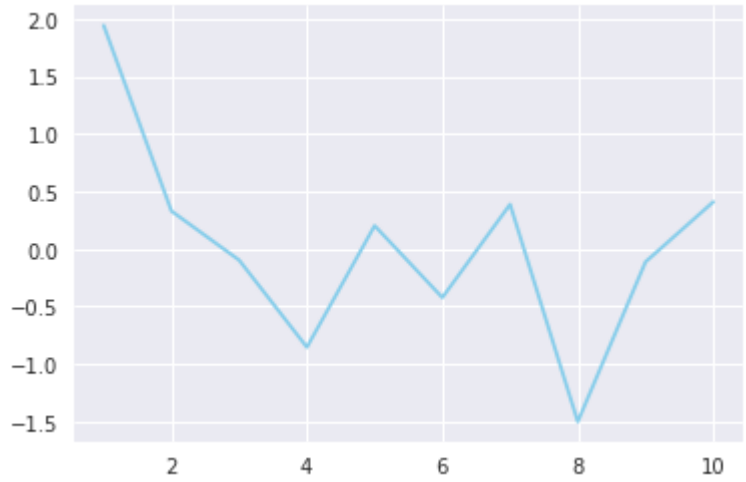
In [69]:
```
sns.distplot( Waves["significant_wave_height"] )
```

```
/usr/local/lib/python3.4/dist-packages/matplotlib-2.1.1+1236.g869c984f5-py3.4
-linux-x86_64.egg/matplotlib/axes/_axes.py:6408: UserWarning: The 'normed' kw
arg is deprecated, and has been replaced by the 'density' kwarg.
  warnings.warn("The 'normed' kwarg is deprecated, and has been "
```

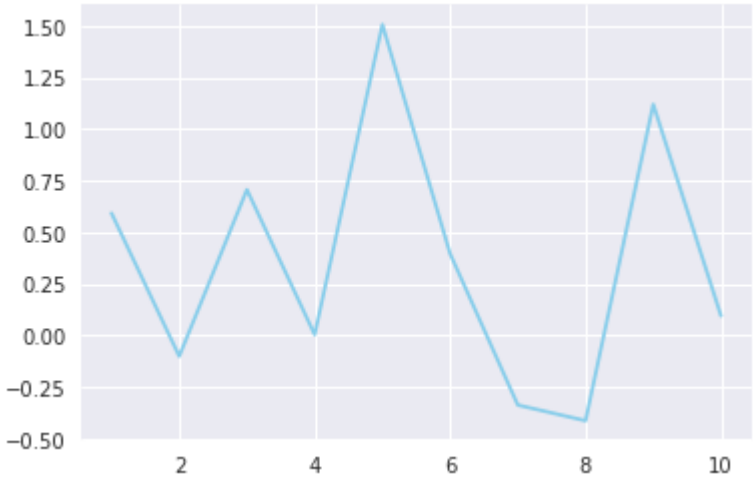
Out[69]:
```
<matplotlib.axes._subplots.AxesSubplot at 0x7f417d6469e8>
```



In [70]:
```
Waves=pd.DataFrame({'sea_surface_temperature': range(1,11), 'maximum_wave_heig
ht': np.random.randn(10) })
plt.plot( 'sea_surface_temperature', 'maximum_wave_height', data=Waves, color=
'skyblue')
plt.show()
#Displays a relationship of the max wave height in comparison to the approxima
te sea surface temperature.
```

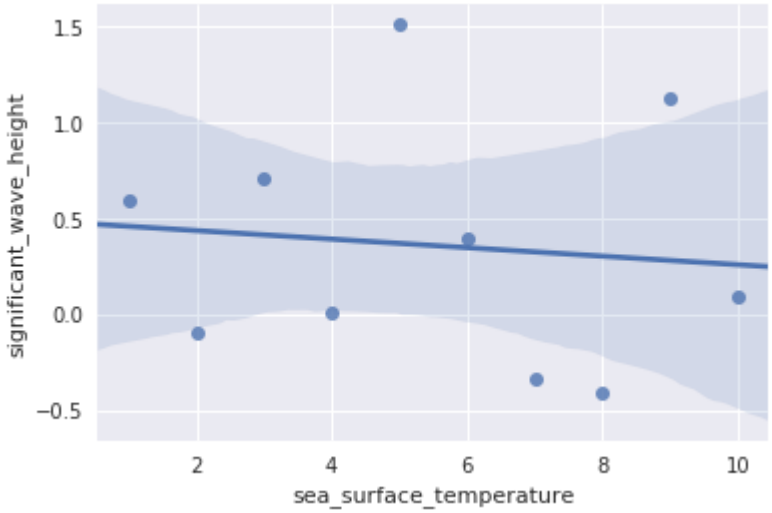


In [71]:
```
Waves=pd.DataFrame({'sea_surface_temperature': range(1,11), 'significant_wave_
height': np.random.randn(10) })
plt.plot( 'sea_surface_temperature', 'significant_wave_height', data=Waves, co
lor='skyblue')
print(plt.show())

sns.regplot(x=Waves["sea_surface_temperature"], y=Waves["significant_wave_heig
ht"])
#Displays a relationship of the significant wave height in comparison to the a
pproximate sea surface temperature.
```



None

Out[71]: <matplotlib.axes._subplots.AxesSubplot at 0x7f417d3a3d68>



Surprises

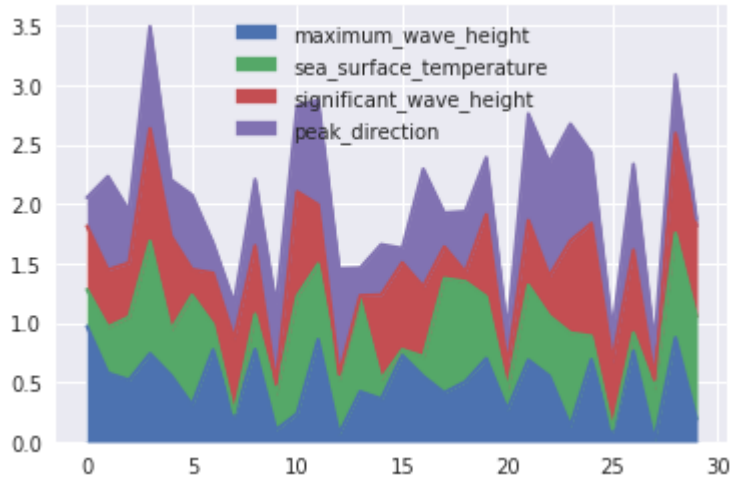
Surprises I did not have any surprises so far in my data. The majority of shark attacks occur near the shore and in the surf zone because their natural preys live in these areas. But attacks also take place in steep underwater drop-offs, where divers often swim. The wave height should not be a surprise where the attacks will take place.

Next Steps, any Obstacles

My next step would be to join the two datasets, which may take some time. Once I do this, it should be much easier to work with. I also plan to use another kaggle file that I was not able to download due to the size of the file. It is not much of an obstacle but it does briefly delay our coding. The file contained moon phases, which we could study and possibly link to our wave data. With this information, we could look at if there was a three-way relationship between waves, sharks attacks, and moon phases.

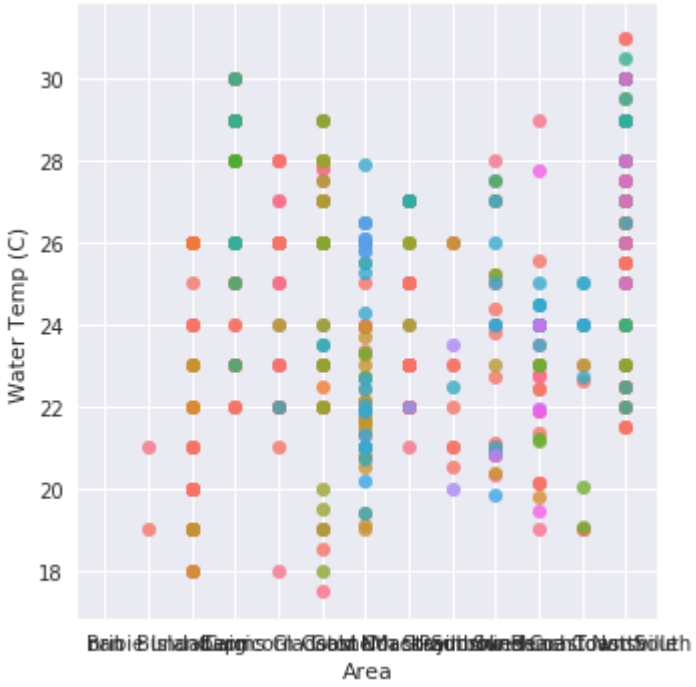
In [72]:
```
Waves = pd.DataFrame(np.random.rand(30, 4), columns=['maximum_wave_height', 's
ea_surface_temperature', 'significant_wave_height',
'peak_direction'])

# plot
Waves.plot.area()
# The height of each coloured stack represents the percentage proportion of th
at category at a given point in time. For this
# I wanted to see the the categories of the maximum height, sea surface temper
ature, significant wave height, and the peak
#direction of where the waves are coming from.
```

Out[72]:
```
<matplotlib.axes._subplots.AxesSubplot at 0x7f417d38aef0>
```



In [73]:
```
sns.lmplot( x="Area", y="Water Temp (C)", data=Control, fit_reg=False, hue='Species Name', legend=False)
# Shows the area and water temperature with what species of shark attacked.
# Will adjust X and Y axis later once I figure out how to.
```

Out[73]: <seaborn.axisgrid.FacetGrid at 0x7f417d38a898>



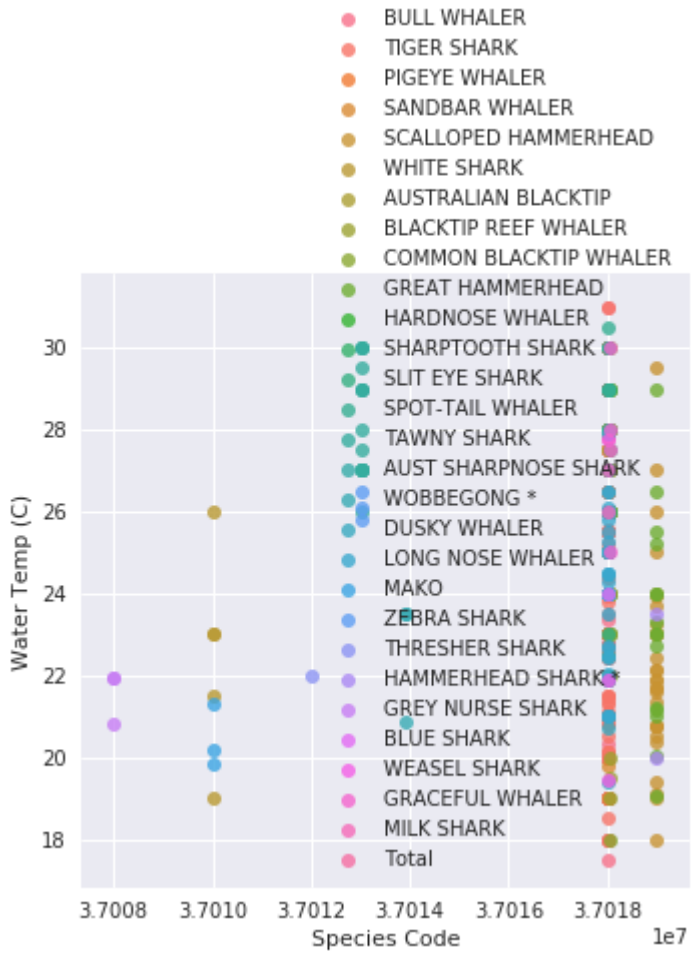
In [74]:
```
Control.head()
```

Out[74]:

	Species Name	Species Code	Date	Area	Location	Latitude	Longitude	
0	BULL WHALER	37018021.0	8/4/2017	Bribie Island	Woorim (Bribie Island)	-27.06835189	153.2113376	De
1	TIGER SHARK	37018022.0	8/8/2017	Bribie Island	Woorim (Bribie Island)	27.06511	153.2108	Eu
2	BULL WHALER	37018021.0	3/3/2017	Bundaberg	Neilson Park	-24.80429012	152.4641092	De
3	BULL WHALER	37018021.0	3/3/2017	Bundaberg	Kellys Beach	-24.83788865	152.4673179	De
4	BULL WHALER	37018021.0	17/03/2017	Bundaberg	Neilson Park	-24.80864323	152.4327342	De

In [75]:
```
sns.lmplot( x="Species Code", y="Water Temp (C)", data=Control, fit_reg=False,
hue='Species Name', legend=False)

plt.legend(loc='lower right')
```

Out[75]: <matplotlib.legend.Legend at 0x7f417e3c1f98>



In [76]:
```
Waves = pd.read_csv('Buoys-Waves.csv')
Control = pd.read_csv('control.csv')
```

In [77]:
```
print(Waves)
print(Control)
```

	Date/Time	Hs	Hmax	Tz	Tp	Peak Direction	SST
0	1/1/2017 0:00	-99.900	-99.90	-99.900	-99.900	-99.9	-99.90
1	1/1/2017 0:30	0.875	1.39	4.421	4.506	-99.9	-99.90
2	1/1/2017 1:00	0.763	1.15	4.520	5.513	49.0	25.65
3	1/1/2017 1:30	0.770	1.41	4.582	5.647	75.0	25.50
4	1/1/2017 2:00	0.747	1.16	4.515	5.083	91.0	25.45
5	1/1/2017 2:30	0.718	1.61	4.614	6.181	68.0	25.45
6	1/1/2017 3:00	0.707	1.34	4.568	4.705	73.0	25.50
7	1/1/2017 3:30	0.729	1.21	4.786	4.484	63.0	25.50
8	1/1/2017 4:00	0.733	1.20	4.897	5.042	68.0	25.50
9	1/1/2017 4:30	0.711	1.29	5.019	8.439	66.0	25.50
10	1/1/2017 5:00	0.698	1.11	4.867	4.584	64.0	25.55
11	1/1/2017 5:30	0.686	1.14	4.755	5.211	56.0	25.55
12	1/1/2017 6:00	0.721	1.12	4.843	5.813	67.0	25.50
13	1/1/2017 6:30	0.679	1.22	4.948	4.710	81.0	25.45
14	1/1/2017 7:00	0.660	1.08	5.068	5.353	90.0	25.45
15	1/1/2017 7:30	0.662	1.18	5.263	7.436	67.0	25.40
16	1/1/2017 8:00	0.653	1.21	5.007	6.001	90.0	25.45
17	1/1/2017 8:30	0.665	1.17	4.952	6.414	90.0	25.55
18	1/1/2017 9:00	0.684	1.55	5.022	6.691	88.0	25.60
19	1/1/2017 9:30	0.679	1.09	4.926	6.804	88.0	25.65
20	1/1/2017 10:00	0.667	1.12	4.928	6.641	122.0	25.75
21	1/1/2017 10:30	0.688	1.13	4.808	5.958	91.0	25.70
22	1/1/2017 11:00	0.644	0.99	4.559	6.691	92.0	25.90
23	1/1/2017 11:30	0.694	1.18	4.442	7.122	98.0	25.70
24	1/1/2017 12:00	0.707	1.59	4.314	7.019	97.0	26.00
25	1/1/2017 12:30	0.714	1.37	4.140	8.154	88.0	26.05
26	1/1/2017 13:00	0.739	1.19	4.149	5.668	98.0	26.05
27	1/1/2017 13:30	0.846	1.51	3.961	7.055	81.0	26.05
28	1/1/2017 14:00	0.815	1.23	3.963	3.833	73.0	26.05
29	1/1/2017 14:30	0.903	1.63	4.072	3.652	53.0	26.15
...	...	...	...	...	...	...	...
43698	30/06/2019 09:00	1.854	3.50	7.207	9.824	106.0	21.95
43699	30/06/2019 09:30	1.768	2.57	6.988	12.898	106.0	21.95
43700	30/06/2019 10:00	1.815	2.87	7.118	9.457	98.0	21.95
43701	30/06/2019 10:30	1.840	3.48	7.272	10.152	105.0	21.95
43702	30/06/2019 11:00	1.911	3.34	7.668	9.796	97.0	21.95
43703	30/06/2019 11:30	1.757	3.12	7.604	12.277	97.0	21.95
43704	30/06/2019 12:00	1.766	3.50	7.096	10.156	94.0	22.00
43705	30/06/2019 12:30	1.829	3.61	6.956	9.741	102.0	22.00
43706	30/06/2019 13:00	1.961	2.89	8.475	12.916	83.0	22.00
43707	30/06/2019 13:30	1.963	3.10	8.159	11.705	85.0	22.05
43708	30/06/2019 14:00	2.030	2.99	7.825	11.535	95.0	22.05
43709	30/06/2019 14:30	1.952	3.06	7.891	9.822	87.0	22.05
43710	30/06/2019 15:00	1.940	3.70	8.076	10.681	90.0	22.05
43711	30/06/2019 15:30	2.029	3.60	8.039	12.955	84.0	22.05
43712	30/06/2019 16:00	1.975	3.32	8.456	10.298	91.0	22.05
43713	30/06/2019 16:30	1.977	3.88	8.205	11.585	84.0	22.05
43714	30/06/2019 17:00	2.028	3.12	8.717	11.915	90.0	22.05
43715	30/06/2019 17:30	2.001	3.33	8.489	12.837	104.0	22.00
43716	30/06/2019 18:00	2.001	3.25	8.885	11.475	97.0	22.00
43717	30/06/2019 18:30	2.203	3.95	9.485	12.852	99.0	22.00
43718	30/06/2019 19:00	2.122	3.56	8.982	12.973	97.0	22.00
43719	30/06/2019 19:30	2.208	4.34	8.772	10.231	97.0	22.00
43720	30/06/2019 20:00	2.077	3.16	9.504	12.260	95.0	22.00
43721	30/06/2019 20:30	2.320	4.13	9.025	12.780	92.0	21.95
43722	30/06/2019 21:00	2.174	3.30	9.557	12.875	94.0	21.95

```
43723  30/06/2019 21:30   2.299   3.60   9.281  12.765            94.0  21.95
43724  30/06/2019 22:00   2.075   3.04   9.303  12.722            95.0  21.95
43725  30/06/2019 22:30   2.157   3.43   9.168  12.890            97.0  21.95
43726  30/06/2019 23:00   2.087   2.84   8.706  10.963            92.0  21.95
43727  30/06/2019 23:30   1.926   2.98   8.509  12.228            84.0  21.95

[43728 rows x 7 columns]
              Species Name  Species Code        Date           Area  \
0              BULL WHALER    37018021.0    8/4/2017  Bribie Island
1              TIGER SHARK    37018022.0    8/8/2017  Bribie Island
2              BULL WHALER    37018021.0    3/3/2017      Bundaberg
3              BULL WHALER    37018021.0    3/3/2017      Bundaberg
4              BULL WHALER    37018021.0  17/03/2017      Bundaberg
5              BULL WHALER    37018021.0  14/09/2017      Bundaberg
6              BULL WHALER    37018021.0   2/11/2017      Bundaberg
7              BULL WHALER    37018021.0   2/11/2017      Bundaberg
8            PIGEYE WHALER    37018026.0   12/3/2017      Bundaberg
9            PIGEYE WHALER    37018026.0    6/4/2017      Bundaberg
10           PIGEYE WHALER    37018026.0  11/10/2017      Bundaberg
11         SANDBAR WHALER     37018007.0    9/4/2017      Bundaberg
12         SANDBAR WHALER     37018007.0   12/4/2017      Bundaberg
13         SANDBAR WHALER     37018007.0   12/4/2017      Bundaberg
14         SANDBAR WHALER     37018007.0   12/4/2017      Bundaberg
15         SANDBAR WHALER     37018007.0  15/08/2017      Bundaberg
16   SCALLOPED HAMMERHEAD     37019001.0  26/07/2017      Bundaberg
17   SCALLOPED HAMMERHEAD     37019001.0  13/10/2017      Bundaberg
18   SCALLOPED HAMMERHEAD     37019001.0  16/11/2017      Bundaberg
19             TIGER SHARK    37018022.0    9/1/2017      Bundaberg
20             TIGER SHARK    37018022.0  24/01/2017      Bundaberg
21             TIGER SHARK    37018022.0  21/02/2017      Bundaberg
22             TIGER SHARK    37018022.0  23/02/2017      Bundaberg
23             TIGER SHARK    37018022.0  25/02/2017      Bundaberg
24             TIGER SHARK    37018022.0    6/3/2017      Bundaberg
25             TIGER SHARK    37018022.0  17/03/2017      Bundaberg
26             TIGER SHARK    37018022.0  23/04/2017      Bundaberg
27             TIGER SHARK    37018022.0  23/04/2017      Bundaberg
28             TIGER SHARK    37018022.0  30/04/2017      Bundaberg
29             TIGER SHARK    37018022.0  18/05/2017      Bundaberg
..                     ...           ...         ...            ...
481            TIGER SHARK    37018022.0    2/5/2017     Townsville
482            TIGER SHARK    37018022.0    4/5/2017     Townsville
483            TIGER SHARK    37018022.0    6/5/2017     Townsville
484            TIGER SHARK    37018022.0    9/5/2017     Townsville
485            TIGER SHARK    37018022.0  13/05/2017     Townsville
486            TIGER SHARK    37018022.0  20/05/2017     Townsville
487            TIGER SHARK    37018022.0    5/6/2017     Townsville
488            TIGER SHARK    37018022.0    7/6/2017     Townsville
489            TIGER SHARK    37018022.0    9/6/2017     Townsville
490            TIGER SHARK    37018022.0  24/06/2017     Townsville
491            TIGER SHARK    37018022.0  24/06/2017     Townsville
492            TIGER SHARK    37018022.0  24/06/2017     Townsville
493            TIGER SHARK    37018022.0    3/7/2017     Townsville
494            TIGER SHARK    37018022.0    6/7/2017     Townsville
495            TIGER SHARK    37018022.0    6/7/2017     Townsville
496            TIGER SHARK    37018022.0    1/8/2017     Townsville
497            TIGER SHARK    37018022.0    1/8/2017     Townsville
498            TIGER SHARK    37018022.0   12/8/2017     Townsville
```

499	TIGER SHARK	37018022.0	26/08/2017	Townsville
500	TIGER SHARK	37018022.0	6/10/2017	Townsville
501	TIGER SHARK	37018022.0	23/10/2017	Townsville
502	TIGER SHARK	37018022.0	23/10/2017	Townsville
503	TIGER SHARK	37018022.0	28/10/2017	Townsville
504	TIGER SHARK	37018022.0	28/10/2017	Townsville
505	TIGER SHARK	37018022.0	25/11/2017	Townsville
506	TIGER SHARK	37018022.0	25/11/2017	Townsville
507	TIGER SHARK	37018022.0	15/12/2017	Townsville
508	TIGER SHARK	37018022.0	23/12/2017	Townsville
509	TIGER SHARK	37018022.0	23/12/2017	Townsville
510	Total	NaN	NaN	NaN

	Location	Latitude	Longitude	Fate
0	Woorim (Bribie Island)	-27.06835189	153.2113376	Dead
1	Woorim (Bribie Island)	27.06511	153.2108	Euthanised
2	Neilson Park	-24.80429012	152.4641092	Dead
3	Kellys Beach	-24.83788865	152.4673179	Dead
4	Neilson Park	-24.80864323	152.4327342	Dead
5	Neilson Park	-24.80061173	152.4609586	Dead
6	Neilson Park	-24.80654196	152.4651796	Dead
7	Kellys Beach	-24.82150404	152.4715669	Dead
8	Neilson Park	-24.80221732	152.4631429	Dead
9	Kellys Beach	-24.81967477	152.4720265	Dead
10	Kellys Beach	-24.81919868	152.4721487	Dead
11	Neilson Park	-24.82228506	152.4723612	Dead
12	Kellys Beach	-24.82236276	152.4711823	Dead
13	Kellys Beach	-24.81710664	152.4719566	Dead
14	Neilson Park	-24.80097378	152.461938	Dead
15	Neilson Park	-24.8015751	152.4625049	Euthanised
16	Neilson Park	-24.80775495	152.4657223	Dead
17	Neilson Park	-24.80423325	152.4639286	Dead
18	Kellys Beach	-24.82139063	152.4718313	Dead
19	Kellys Beach	-24.81971253	152.4719653	Dead
20	Kellys Beach	-24.81779989	152.4563632	Euthanised
21	Kellys Beach	-24.81870306	152.4719942	Dead
22	Kellys Beach	-24.83681341	152.4679906	Euthanised
23	Neilson Park	-24.81488703	152.459434	Dead
24	Kellys Beach	-24.82159574	152.4718579	Dead
25	Kellys Beach	-24.81614829	152.4675384	Dead
26	Kellys Beach	-24.81703091	152.4719534	Dead
27	Neilson Park	-24.80055716	152.4622399	Euthanised
28	Neilson Park	-24.80109226	152.462938	Euthanised
29	Kellys Beach	-24.82670593	152.4707625	Dead
..	...	...	...	...
481	Nelly Bay	-19.17538333	146.8495167	Dead
482	Radical Bay	-19.10826667	146.8765667	Euthanised
483	Radical Bay	-19.10826667	146.8765667	Dead
484	Horseshoe Bay	-19.10445	146.85945	Dead
485	Horseshoe Bay	-19.103	146.8597667	Dead
486	Alma Bay	-19.15188333	146.8744	Dead
487	Horseshoe Bay	-19.11121667	146.8424833	Dead
488	Horseshoe Bay	-19.10445	146.85945	Euthanised
489	Horseshoe Bay	-19.11121667	146.8424833	Dead
490	Alma Bay	-19.14871667	146.87355	Euthanised
491	Horseshoe Bay	-19.103	146.8597667	Euthanised
492	Florence Bay	-19.1217	146.8853333	Euthanised

493	Radical Bay	-19.10761667	146.8752333	Dead
494	Horseshoe Bay	-19.1037	146.85955	Dead
495	Horseshoe Bay	-19.10445	146.85945	Euthanised
496	Horseshoe Bay	-19.1037	146.85955	Euthanised
497	Alma Bay	-19.14871667	146.87355	Euthanised
498	Alma Bay	-19.15101667	146.8742333	Euthanised
499	Horseshoe Bay	-19.11473333	146.8501833	Euthanised
500	Radical Bay	-19.10861667	146.8771667	Dead
501	Florence Bay	-19.1217	146.8853333	Dead
502	Florence Bay	-19.1217	146.8853333	Euthanised
503	Alma Bay	-19.14753333	146.8737167	Dead
504	Palarenda Beach	-19.19758333	146.7773833	Euthanised
505	Radical Bay	-19.10796667	146.8759	Dead
506	Florence Bay	-19.1241	146.8852833	Euthanised
507	Alma Bay	-19.15101667	146.8742333	Dead
508	The Strand	-19.2435	146.8157833	Euthanised
509	Florence Bay	-19.12328333	146.8853167	Dead
510	NaN	NaN	NaN	NaN

	Length (m)	Water Temp (C)	Number Caught
0	1.55	21.0	1
1	3.55	19.0	1
2	1.56	26.0	1
3	1.79	26.0	1
4	1.56	26.0	1
5	1.72	20.0	1
6	1.87	24.0	1
7	2.24	24.0	1
8	1.17	26.0	1
9	1.63	23.0	1
10	1.66	23.0	1
11	1.43	22.0	1
12	1.62	22.0	1
13	1.57	22.0	1
14	1.77	22.0	1
15	1.53	19.0	1
16	2.57	18.0	1
17	2.14	23.0	1
18	2.46	23.0	1
19	3.79	25.0	1
20	3.26	26.0	1
21	1.48	26.0	1
22	3.25	26.0	1
23	2.15	26.0	1
24	2.13	26.0	1
25	3.74	26.0	1
26	1.71	21.0	1
27	1.60	21.0	1
28	2.61	20.0	1
29	2.22	20.0	1
..	...	...	...
481	1.08	25.5	1
482	2.80	25.5	1
483	1.08	25.5	1
484	0.80	25.5	1
485	1.09	25.0	1
486	1.85	24.0	1

487	1.20	23.0	1
488	1.25	22.5	1
489	3.30	22.5	1
490	2.50	21.5	1
491	1.85	21.5	1
492	1.80	21.5	1
493	2.15	22.0	1
494	1.18	22.5	1
495	1.19	22.5	1
496	3.10	22.0	1
497	1.25	22.0	1
498	2.65	23.0	1
499	2.60	24.0	1
500	1.95	26.0	1
501	1.50	26.0	1
502	3.40	26.0	1
503	3.15	26.5	1
504	2.10	26.5	1
505	2.60	27.0	1
506	2.50	27.0	1
507	1.85	29.0	1
508	2.20	29.0	1
509	1.90	29.0	1
510	NaN	NaN	510

[511 rows x 11 columns]

In [78]:
```
Waves_ControlTogether = pd.concat([Waves, Control], axis = 1)
Waves_ControlTogether = Waves_ControlTogether.rename(columns = {'Hs' : 'signif
icant_wave_height' , 'Hmax' : 'maximum_wave_height', 'Tz' : 'zero_wave_period'
,
                        'Tp' : 'peak_wave_period' , 'SST' : 'sea_surface_temper
ature' , 'Peak Direction' : 'peak_direction'})
Waves_ControlTogether
```

Out[78]:

	Date/Time	significant_wave_height	maximum_wave_height	zero_wave_period	
0	1/1/2017 0:00	-99.900	-99.90	-99.900	-
1	1/1/2017 0:30	0.875	1.39	4.421	4
2	1/1/2017 1:00	0.763	1.15	4.520	5
3	1/1/2017 1:30	0.770	1.41	4.582	5
4	1/1/2017 2:00	0.747	1.16	4.515	5
5	1/1/2017 2:30	0.718	1.61	4.614	6
6	1/1/2017 3:00	0.707	1.34	4.568	4
7	1/1/2017 3:30	0.729	1.21	4.786	4
8	1/1/2017 4:00	0.733	1.20	4.897	5
9	1/1/2017 4:30	0.711	1.29	5.019	8
10	1/1/2017 5:00	0.698	1.11	4.867	4
11	1/1/2017 5:30	0.686	1.14	4.755	5
12	1/1/2017 6:00	0.721	1.12	4.843	5
13	1/1/2017 6:30	0.679	1.22	4.948	4
14	1/1/2017 7:00	0.660	1.08	5.068	5
15	1/1/2017 7:30	0.662	1.18	5.263	7
16	1/1/2017 8:00	0.653	1.21	5.007	6

	Date/Time	significant_wave_height	maximum_wave_height	zero_wave_period	
17	1/1/2017 8:30	0.665	1.17	4.952	
18	1/1/2017 9:00	0.684	1.55	5.022	
19	1/1/2017 9:30	0.679	1.09	4.926	
20	1/1/2017 10:00	0.667	1.12	4.928	
21	1/1/2017 10:30	0.688	1.13	4.808	
22	1/1/2017 11:00	0.644	0.99	4.559	
23	1/1/2017 11:30	0.694	1.18	4.442	
24	1/1/2017 12:00	0.707	1.59	4.314	
25	1/1/2017 12:30	0.714	1.37	4.140	
26	1/1/2017 13:00	0.739	1.19	4.149	
27	1/1/2017 13:30	0.846	1.51	3.961	
28	1/1/2017 14:00	0.815	1.23	3.963	
29	1/1/2017 14:30	0.903	1.63	4.072	
...	...	...	...	...	
43698	30/06/2019 09:00	1.854	3.50	7.207	
43699	30/06/2019 09:30	1.768	2.57	6.988	
43700	30/06/2019 10:00	1.815	2.87	7.118	
43701	30/06/2019 10:30	1.840	3.48	7.272	

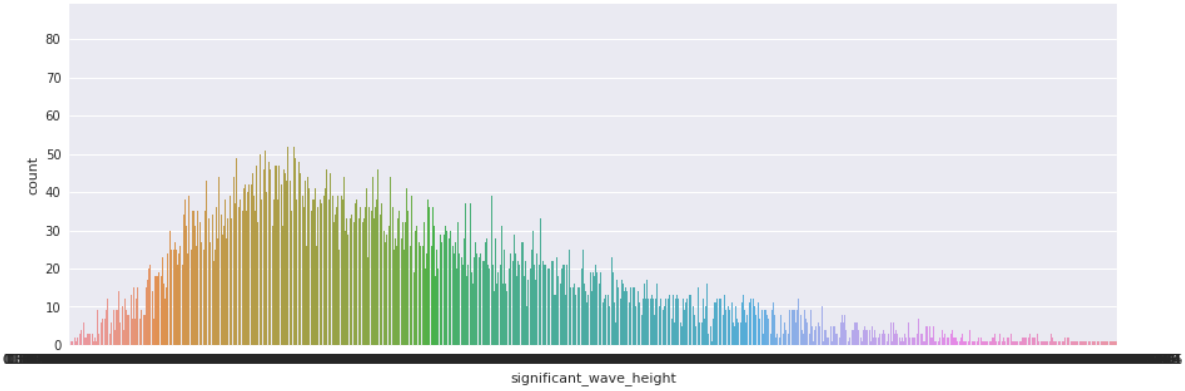
	Date/Time	significant_wave_height	maximum_wave_height	zero_wave_period	
43702	30/06/2019 11:00	1.911	3.34	7.668	
43703	30/06/2019 11:30	1.757	3.12	7.604	
43704	30/06/2019 12:00	1.766	3.50	7.096	
43705	30/06/2019 12:30	1.829	3.61	6.956	
43706	30/06/2019 13:00	1.961	2.89	8.475	
43707	30/06/2019 13:30	1.963	3.10	8.159	
43708	30/06/2019 14:00	2.030	2.99	7.825	
43709	30/06/2019 14:30	1.952	3.06	7.891	
43710	30/06/2019 15:00	1.940	3.70	8.076	
43711	30/06/2019 15:30	2.029	3.60	8.039	
43712	30/06/2019 16:00	1.975	3.32	8.456	
43713	30/06/2019 16:30	1.977	3.88	8.205	
43714	30/06/2019 17:00	2.028	3.12	8.717	
43715	30/06/2019 17:30	2.001	3.33	8.489	
43716	30/06/2019 18:00	2.001	3.25	8.885	
43717	30/06/2019 18:30	2.203	3.95	9.485	
43718	30/06/2019 19:00	2.122	3.56	8.982	
43719	30/06/2019 19:30	2.208	4.34	8.772	

	Date/Time	significant_wave_height	maximum_wave_height	zero_wave_period	
43720	30/06/2019 20:00	2.077	3.16	9.504	
43721	30/06/2019 20:30	2.320	4.13	9.025	
43722	30/06/2019 21:00	2.174	3.30	9.557	
43723	30/06/2019 21:30	2.299	3.60	9.281	
43724	30/06/2019 22:00	2.075	3.04	9.303	
43725	30/06/2019 22:30	2.157	3.43	9.168	
43726	30/06/2019 23:00	2.087	2.84	8.706	
43727	30/06/2019 23:30	1.926	2.98	8.509	

43728 rows × 18 columns

In [79]:
```
fig,ax = plt.subplots(figsize=(15,5))
ax = sns.countplot(Waves_ControlTogether['significant_wave_height'])
plt.show()
```

```
/usr/local/lib/python3.4/dist-packages/seaborn/categorical.py:1428: FutureWar
ning: remove_na is deprecated and is a private function. Do not use.
  stat_data = remove_na(group_data)
```



In [ ]: