In [178]:
```
import matplotlib.pyplot as plt
import numpy as np
import pandas as pd
import seaborn as sns
import math
%pylab inline
pd.set_option('display.height', 1000)
pd.set_option('display.max_rows', 500)
pd.set_option('display.max_columns', 500)
pd.set_option('display.width', 1000)
```

```
Populating the interactive namespace from numpy and matplotlib
height has been deprecated.
```

Main questions: Which commonly known batting stats (pre-season) has highest impact on salary? How is the impact in context of average salary?

Strategy:

1. Create dataframe -Focus on batting metrics that are typically displayed in baseball games, on TV
    - BA : (Hits/At bats). Using pandas to create H/AB columns in batting dataframe
    - HR : homerun
    - RBI : RBI
    - SO : strikeout
    - BB : walk
2. Statistical test
    - use Pearson's R test to find the magnitude of correlation between the above stats and salary.
3. Plotting batting stats v.s. salary
    - Plot to visualize the above batting stats' correlation with salary

Creating dataframe for batting (pre-season)

In [179]:
```
#function for reading csv files into dataframe
def read_csv(filename):
    reader = pd.read_csv(filename)
    return reader
```

Read files for batting and salary

In [180]:
```
batting = read_csv('Batting.csv' )
batting.head()
```

Out[180]:

	playerID	yearID	stint	teamID	lgID	G	AB	R	H	2B	3B	HR	RBI	SB	CS
0	abercda01	1871	1	TRO	NaN	1	4.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1	addybo01	1871	1	RC1	NaN	25	118.0	30.0	32.0	6.0	0.0	0.0	13.0	8.0	1.0
2	allisar01	1871	1	CL1	NaN	29	137.0	28.0	40.0	4.0	5.0	0.0	19.0	3.0	1.0
3	allisdo01	1871	1	WS3	NaN	27	133.0	28.0	44.0	10.0	2.0	2.0	27.0	1.0	1.0
4	ansonca01	1871	1	RC1	NaN	25	120.0	29.0	39.0	11.0	3.0	0.0	16.0	6.0	2.0

In [181]:
```
salaries = read_csv('Salaries.csv' )
salaries.head()
```

Out[181]:

	yearID	teamID	lgID	playerID	salary
0	1985	ATL	NL	barkele01	870000
1	1985	ATL	NL	bedrost01	550000
2	1985	ATL	NL	benedbr01	545000
3	1985	ATL	NL	campri01	633333
4	1985	ATL	NL	ceronri01	625000

Creating a column in the dataframe for players' batting average

Plan

1. creating a new 'BA'(batting average) column, and use groupby() to group players.
2. merging salaries dataframe and batting dataframe (with batting average) using playerID that is common to the list salaries.

In [182]:
```
#Insert new 'BA' column
batting ['BA'] = batting['H']/batting['AB']
batting.head() # after looking at batting as a whole, records with 'NaN' BA
```

Out[182]:

	playerID	yearID	stint	teamID	lgID	G	AB	R	H	2B	3B	HR	RBI	SB	CS
0	abercda01	1871	1	TRO	NaN	1	4.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1	addybo01	1871	1	RC1	NaN	25	118.0	30.0	32.0	6.0	0.0	0.0	13.0	8.0	1.0
2	allisar01	1871	1	CL1	NaN	29	137.0	28.0	40.0	4.0	5.0	0.0	19.0	3.0	1.0
3	allisdo01	1871	1	WS3	NaN	27	133.0	28.0	44.0	10.0	2.0	2.0	27.0	1.0	1.0
4	ansonca01	1871	1	RC1	NaN	25	120.0	29.0	39.0	11.0	3.0	0.0	16.0	6.0	2.0

Limit the batting dataframe to a subset of player within the last 5 years (2010-2015)

In [183]:
```
select_batting_last5yrs = batting['yearID'] >=2010
batting_last5yrs = batting [select_batting_last5yrs]
batting_last5yrs.head()
```

Out[183]:

	playerID	yearID	stint	teamID	lgID	G	AB	R	H	2B	3B	HR	RBI	S
92849	aardsda01	2010	1	SEA	AL	53	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0
92850	abadfe01	2010	1	HOU	NL	22	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0
92851	abreubo01	2010	1	LAA	AL	154	573.0	88.0	146.0	41.0	1.0	20.0	78.0	2
92852	abreuto01	2010	1	ARI	NL	81	193.0	16.0	45.0	11.0	1.0	1.0	13.0	2
92853	accarje01	2010	1	TOR	AL	5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0

Get rid of BA row that is NaN or 0.00, which is due to player haveing 0.0 H or 0.0 AB

In [184]:
```
batting_last5yrs_1stcleanBA = batting_last5yrs[batting_last5yrs.BA != 0]
batting_last5yrs_2ndcleanBA = batting_last5yrs_1stcleanBA[np.isfinite(battin
batting_last5yrs_2ndcleanBA.head()
```

Out[184]:

	playerID	yearID	stint	teamID	lgID	G	AB	R	H	2B	3B	HR	RBI	S
92851	abreubo01	2010	1	LAA	AL	154	573.0	88.0	146.0	41.0	1.0	20.0	78.0	2
92852	abreuto01	2010	1	ARI	NL	81	193.0	16.0	45.0	11.0	1.0	1.0	13.0	2
92860	aldrico01	2010	1	LAA	AL	5	13.0	0.0	1.0	0.0	1.0	0.0	1.0	0
92861	alfonel01	2010	1	SEA	AL	13	41.0	4.0	9.0	1.0	0.0	1.0	4.0	0
92862	allenbr01	2010	1	ARI	NL	22	45.0	5.0	12.0	3.0	0.0	1.0	6.0	0

Select only players with ABs higher than populations average, to get rid of possible pitchers and pinch hitters.

In [185]:
```
mean_AB = batting_last5yrs_2ndcleanBA['AB'].mean()

finalcleanBA = batting_last5yrs_2ndcleanBA['AB'] >= mean_AB

batting_last5yrs_finalcleanBA = batting_last5yrs_2ndcleanBA[finalcleanBA]
batting_last5yrs_finalcleanBA.head()
```

Out[185]:

	playerID	yearID	stint	teamID	lgID	G	AB	R	H	2B	3B	HR	RBI	S
92851	abreubo01	2010	1	LAA	AL	154	573.0	88.0	146.0	41.0	1.0	20.0	78.0	2
92864	alvarpe01	2010	1	PIT	NL	95	347.0	42.0	89.0	21.0	1.0	16.0	64.0	0
92871	andruel01	2010	1	TEX	AL	148	588.0	88.0	156.0	15.0	3.0	0.0	35.0	3
92884	avilaal01	2010	1	DET	AL	104	294.0	28.0	67.0	12.0	0.0	7.0	31.0	2
92885	avilemi01	2010	1	KCA	AL	110	424.0	63.0	129.0	16.0	3.0	8.0	32.0	1

Create new salary list for players within the last 5 years (2010-2015)

In [186]:
```
select_salaries_last5yrs = salaries['yearID'] >=2010
salaries_last5yrs = salaries [select_salaries_last5yrs]
salaries_last5yrs.head()
```

Out[186]:

	yearID	teamID	lgID	playerID	salary
20624	2010	ARI	NL	abreuto01	407000
20625	2010	ARI	NL	boyerbl01	725000
20626	2010	ARI	NL	drewst01	3400000
20627	2010	ARI	NL	gutieju01	411000
20628	2010	ARI	NL	harenda01	8250000

Merge batting_n_salaries_last5yrs and salaries_last5yrs.merge dataframe to add playerID-specific and yearID-specific to create a dataframe with both players' batting statistics and their salary.

In [187]:
```
batting_n_salaries_last5yrs = salaries_last5yrs.merge(batting_last5yrs_final
batting_n_salaries_last5yrs.head()
```

Out[187]:

	yearID	teamID_x	lgID_x	playerID	salary	stint	teamID_y	lgID_y	G	AB	R	H
0	2010	ARI	NL	drewst01	3400000	1	ARI	NL	151	565.0	83.0	1
1	2010	ARI	NL	johnske05	2350000	1	ARI	NL	154	585.0	93.0	1
2	2010	ARI	NL	larocad01	4500000	1	ARI	NL	151	560.0	75.0	1
3	2010	ARI	NL	montemi01	2000000	1	ARI	NL	85	297.0	36.0	7
4	2010	ARI	NL	parrage01	405500	1	ARI	NL	133	364.0	31.0	9

In [188]:
```
#verify the merged list 'batting_n_salaries_last5yrs' for salary and playerI
select_drew = batting_n_salaries_last5yrs['playerID'] == 'drewst01'
test_drew = batting_n_salaries_last5yrs[select_drew]
test_drew
```

Out[188]:

	yearID	teamID_x	lgID_x	playerID	salary	stint	teamID_y	lgID_y	G	AB	R
0	2010	ARI	NL	drewst01	3400000	1	ARI	NL	151	565.0	83.0
295	2011	ARI	NL	drewst01	4650000	1	ARI	NL	86	321.0	44.0
915	2013	BOS	AL	drewst01	9500000	1	BOS	AL	124	442.0	57.0
1635	2015	NYA	AL	drewst01	5000000	1	NYA	AL	131	383.0	43.0

Observed general statistics for the batting/salary (within the last 5 years) dataframe.

In [189]:
```
batting_n_salaries_last5yrs.describe()
```

Out[189]:

	yearID	salary	stint	G	AB	R	H
count	1762.000000	1.762000e+03	1762.000000	1762.000000	1762.000000	1762.000000	17
mean	2012.484109	5.050967e+06	1.024404	121.410897	420.223610	54.832009	11
std	1.702464	5.662530e+06	0.157980	28.771067	130.776456	23.584231	41
min	2010.000000	4.000000e+05	1.000000	51.000000	200.000000	4.000000	31
25%	2011.000000	5.171250e+05	1.000000	99.000000	304.000000	36.000000	76
50%	2012.000000	2.750000e+06	1.000000	126.000000	422.500000	53.000000	10
75%	2014.000000	7.500000e+06	1.000000	147.000000	535.750000	72.000000	14
max	2015.000000	3.300000e+07	3.000000	162.000000	684.000000	136.000000	22

Using Pearson's R to find the magnitude of

correlation between batting metrices and salary

In [192]:
```
#function to find the given average values of specific players
def group_playerID_values (value):
    z = batting_n_salaries_last5yrs
    return z.groupby('playerID').mean()[value]

player_salary = group_playerID_values('salary')
player_BA = group_playerID_values('BA')
player_HR = group_playerID_values('HR')
player_RBI = group_playerID_values('RBI')
player_SO = group_playerID_values('SO')
player_BB = group_playerID_values('BB')

#function for Pearson's R test
def correlation(x, y):
    return (((x-x.mean())/x.std(ddof=0)) * ((y-y.mean())/y.std(ddof=0))).mea

Rvalue_salary_and_BA = correlation(player_salary, player_BA)
Rvalue_salary_and_HR = correlation(player_salary, player_HR)
Rvalue_salary_and_RBI = correlation(player_salary, player_RBI)
Rvalue_salary_and_BB = correlation(player_salary, player_BB)
Rvalue_salary_and_SO = correlation(player_salary, player_SO)




print "Pearson's R values:"
print ""
print 'salary and BA:', Rvalue_salary_and_BA
print ""
print 'salary and HR:', Rvalue_salary_and_HR
print ""
print 'salary and RBI:', Rvalue_salary_and_RBI
print ""
print 'salary and BB:', Rvalue_salary_and_BB
print ""
print 'salary and SO:', Rvalue_salary_and_SO
```

```
Pearson's R values:

salary and BA: 0.284833952637

salary and HR: 0.427740300265

salary and RBI: 0.497880404076

salary and BB: 0.419211073439

salary and SO: 0.134789586788
```

Testing the significance of Pearson's R values

Using the following formula: t* = r√(n−2) / (√(1−r^2)), per the following URL: [https://onlinecourses.science.psu.edu/stat501/node/259 (https://onlinecourses.science.psu.edu/stat501/node/259)]

Where r = Pearson's r

Finding the n for t test below

In [195]:
```
print len(batting_n_salaries_last5yrs['playerID'])
```

```
1762
```

In [196]:
```
#function for obtaining t value for Pearson's R values
def correlation_sig_test(r):
    sqrtA = math.sqrt(1760)
    sqrtB = math.sqrt(1-(r**2))
    return (r * sqrtA)/sqrtB
```

Calculate t values for salary/batting stats R values

> ### Null hypothesis is existence of correlation (rho): rho = 0
>
> ### Alternate hypothesis: rho ≠ 0

In [197]:
```
print "t value for Rvalue_salary_and_BA = ", correlation_sig_test(Rvalue_sala
print "t value for Rvalue_salary_and_HR = ", correlation_sig_test(Rvalue_sala
print "t value for Rvalue_salary_and_RBI = ", correlation_sig_test(Rvalue_sal
print "t value for Rvalue_salary_and_BB = ", correlation_sig_test(Rvalue_sala
print "t value for Rvalue_salary_and_SO = ", correlation_sig_test(Rvalue_sala
```

```
t value for Rvalue_salary_and_BA =  12.4658283974
t value for Rvalue_salary_and_HR =  19.8525049678
t value for Rvalue_salary_and_RBI =  24.0845874911
t value for Rvalue_salary_and_BB =  19.3711953421
t value for Rvalue_salary_and_SO =  5.70681949318
```

Results of t test for salary/batting stats R values:

> **Null hypothesis is rejected for all R values above since t critical value for 1780 degree of freedom**
>
> **for .025 p value(two-tailed test) is between 1.960 and 1.962**
>
> **Thus, all correlations above are significance**

Conclusion 1:

> **Using Pearson's R test and t test it is found that the correlation of the tested batting stats to salary are significant (p = 0.05), and are ranked as follows: RBI > HR > BB > BA > SO. This does not indicate that having higher said stat in isolation will directly result in higher salary, since other stats are not constant for each player while this analysis was performed, as well as unforseen events not detected in our data/tests.**
>
> **In addition, using average batting stats and salary may not be the best approach, however, since there may be aforementioned event(s) that seemingly can disrupt the correlation, e.g. poor performance after a salary raise. Another approach attempting to address this question will be presented below.**

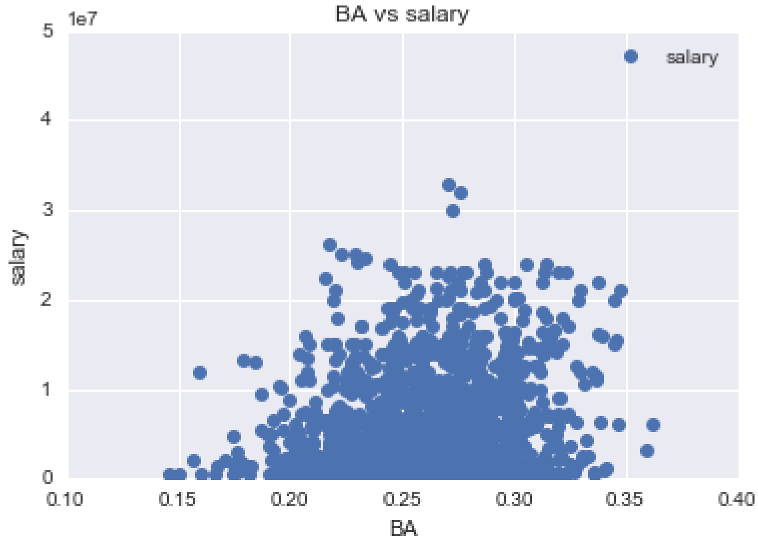
Plotting average batting matrices v.s. average salary

Using scatter plot to visualize correlations

In [198]:
```
axs5yrsBA = batting_n_salaries_last5yrs.plot(x='BA', y='salary', style='o')

axs5yrsBA.set_ylim(100000,50000000)
axs5yrsBA.set_xlim(0.10,0.4)
axs5yrsBA.set_ylabel("salary")
axs5yrsBA.set_title('BA vs salary')
```

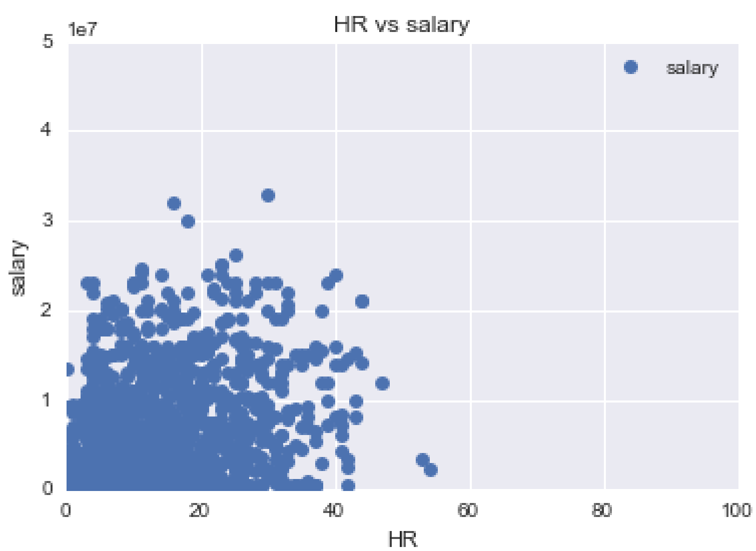
Out[198]: <matplotlib.text.Text at 0x116079490>



In [199]:
```
axs5yrsHR = batting_n_salaries_last5yrs.plot(x='HR', y='salary', style='o')

axs5yrsHR.set_ylim(100000,50000000)
axs5yrsHR.set_xlim(0,100)
axs5yrsHR.set_ylabel("salary")
axs5yrsHR.set_title('HR vs salary')
```

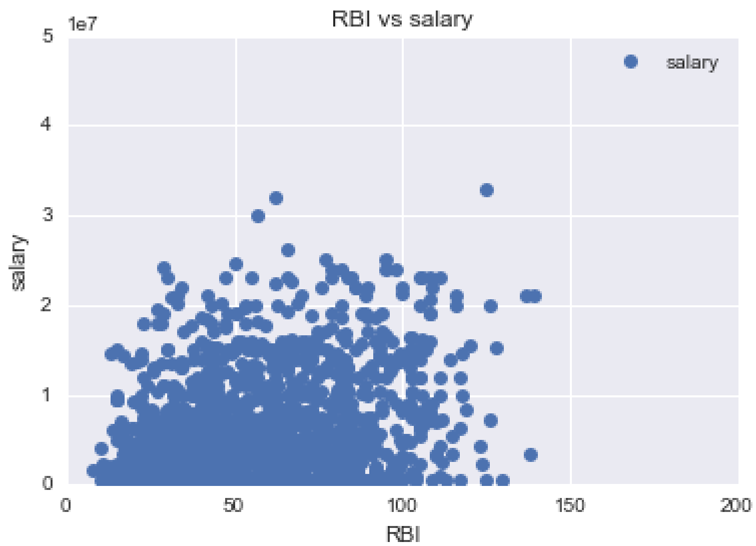
Out[199]: <matplotlib.text.Text at 0x123c7f610>



In [200]:
```
axs5yrsRBI = batting_n_salaries_last5yrs.plot(x='RBI', y='salary', style='o'

axs5yrsRBI.set_ylim(100000,50000000)
axs5yrsRBI.set_xlim(0,200)
axs5yrsRBI.set_ylabel("salary")
axs5yrsRBI.set_title('RBI vs salary')
```

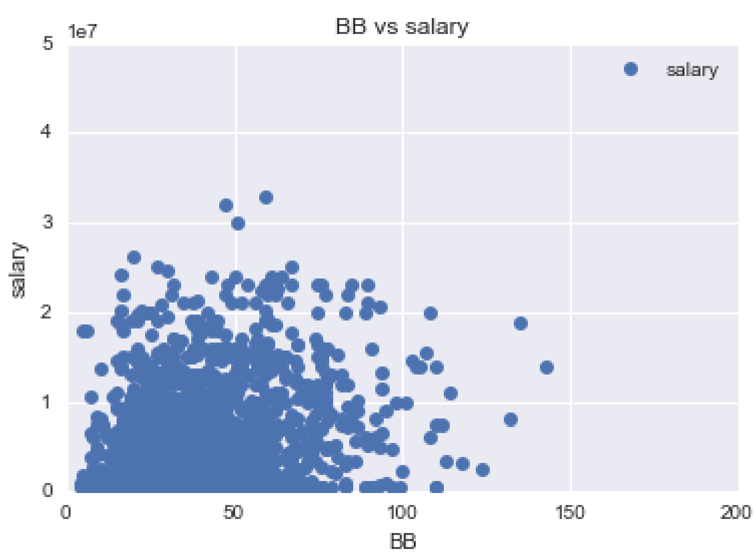
Out[200]: <matplotlib.text.Text at 0x123e51290>



In [201]:
```
axs5yrsBB = batting_n_salaries_last5yrs.plot(x='BB', y='salary', style='o')

axs5yrsBB.set_ylim(100000,50000000)
axs5yrsBB.set_xlim(0,200)
axs5yrsBB.set_ylabel("salary")
axs5yrsBB.set_title('BB vs salary')
```

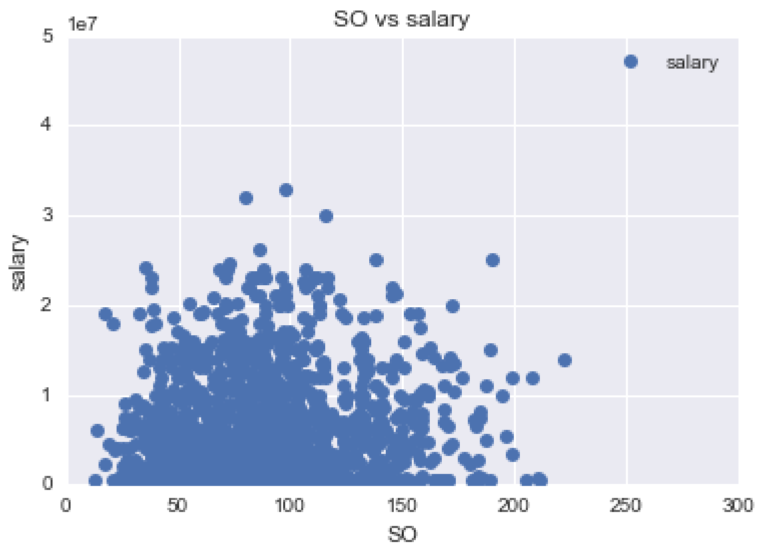
Out[201]: <matplotlib.text.Text at 0x1243f2610>



In [202]:
```
axs5yrsSO = batting_n_salaries_last5yrs.plot(x='SO', y='salary', style='o')

axs5yrsSO.set_ylim(100000,50000000)
axs5yrsSO.set_xlim(0,300)
axs5yrsSO.set_ylabel("salary")
axs5yrsSO.set_title('SO vs salary')
```

Out[202]: <matplotlib.text.Text at 0x1244d9fd0>



Need to resolve the scoatter plots above, although the scatter plot suggests that the correlation is positive for salary and all batting stats.

> **Strategy: Try using qcut() funciton to bin the batting stats to resolve the plots above.**
>
> **Bin BA, then average salary per that Bin > plot with average salary line as a reference.**

In [203]:
```
#function for binning bating stats
def binning(data):
        return pd.qcut(data, [0, 0.2, 0.4, 0.6, 0.8, 1], labels=['5th', '4th
batting_n_salaries_last5yrs['BAbin'] = binning(batting_n_salaries_last5yrs['
batting_n_salaries_last5yrs['HRbin'] = binning(batting_n_salaries_last5yrs['
batting_n_salaries_last5yrs['RBIbin'] = binning(batting_n_salaries_last5yrs[
batting_n_salaries_last5yrs['BBbin'] = binning(batting_n_salaries_last5yrs['
batting_n_salaries_last5yrs['SObin'] = binning(batting_n_salaries_last5yrs['


batting_n_salaries_last5yrs.head()
```

Out[203]:

	yearID	teamID_x	lgID_x	playerID	salary	stint	teamID_y	lgID_y	G	AB	R	H
0	2010	ARI	NL	drewst01	3400000	1	ARI	NL	151	565.0	83.0	1
1	2010	ARI	NL	johnske05	2350000	1	ARI	NL	154	585.0	93.0	1
2	2010	ARI	NL	larocad01	4500000	1	ARI	NL	151	560.0	75.0	1
3	2010	ARI	NL	montemi01	2000000	1	ARI	NL	85	297.0	36.0	7
4	2010	ARI	NL	parrage01	405500	1	ARI	NL	133	364.0	31.0	9

Use binned values to plot (dot plot). The average salary for the whole population is depicted by the blue line.

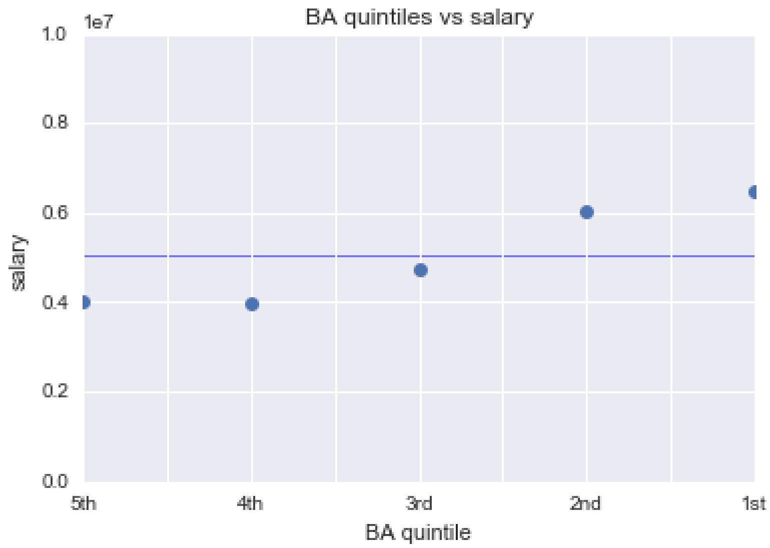
In [208]:
```
salaryBAbinaxs = batting_n_salaries_last5yrs.groupby('BAbin').mean()['salary
axsBAbin = salaryBAbinaxs.plot(x='BAbin', y='salary', style='o')

mean_salary = batting_n_salaries_last5yrs.mean()['salary']

axsBAbin.set_ylim(000000,10000000)
axsBAbin.set_xlabel("BA quintile")
axsBAbin.set_ylabel("salary")
axsBAbin.axhline(y=5050966.57435,xmin=0,xmax=3,c="blue",linewidth=0.5,zorder=

axsBAbin.set_title('BA quintiles vs salary')
```

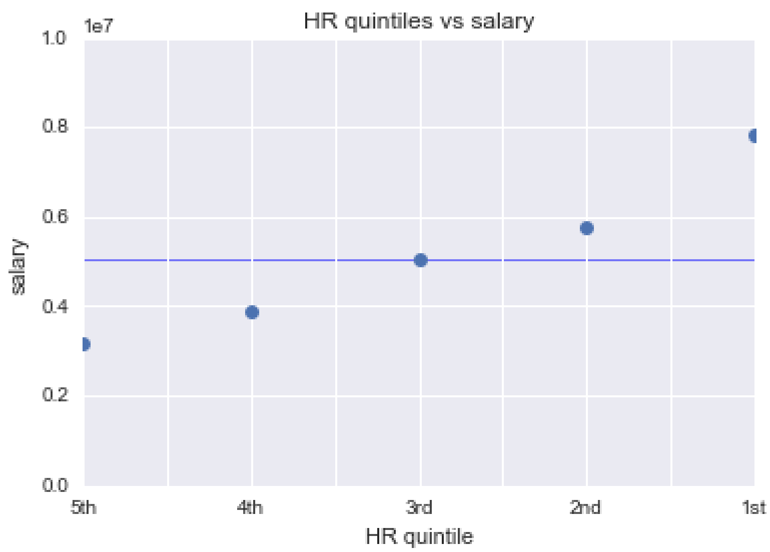
Out[208]: <matplotlib.text.Text at 0x128fcc090>



In [209]:
```
salaryHRbinaxs = batting_n_salaries_last5yrs.groupby('HRbin').mean()['salary
#BAbingroup = batting_n_salaries_last5yrs.groupby('BAbin', as_index=False)
axsHRbin = salaryHRbinaxs.plot(x='HRbin', y='salary', style='o')

axsHRbin.set_ylim(000000,10000000)
axsHRbin.set_xlabel("HR quintile")
axsHRbin.set_ylabel("salary")
axsHRbin.axhline(y=5050966.57435,xmin=0,xmax=3,c="blue",linewidth=0.5,zorder=
axsHRbin.set_title('HR quintiles vs salary')
```

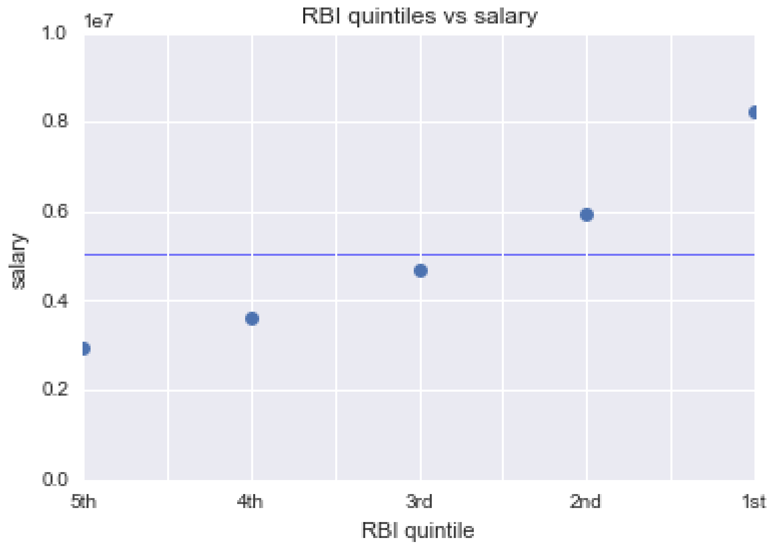
Out[209]: <matplotlib.text.Text at 0x12907ff50>



In [210]:
```
salaryRBIbinaxs = batting_n_salaries_last5yrs.groupby('RBIbin').mean()['sala
#BAbingroup = batting_n_salaries_last5yrs.groupby('BAbin', as_index=False)
axsRBIbin = salaryRBIbinaxs.plot(x='RBIbin', y='salary', style='o')

axsRBIbin.set_ylim(000000,10000000)
axsRBIbin.set_xlabel("RBI quintile")
axsRBIbin.set_ylabel("salary")
axsRBIbin.axhline(y=5050966.57435,xmin=0,xmax=3,c="blue",linewidth=0.5,zorde
axsRBIbin.set_title('RBI quintiles vs salary')
```

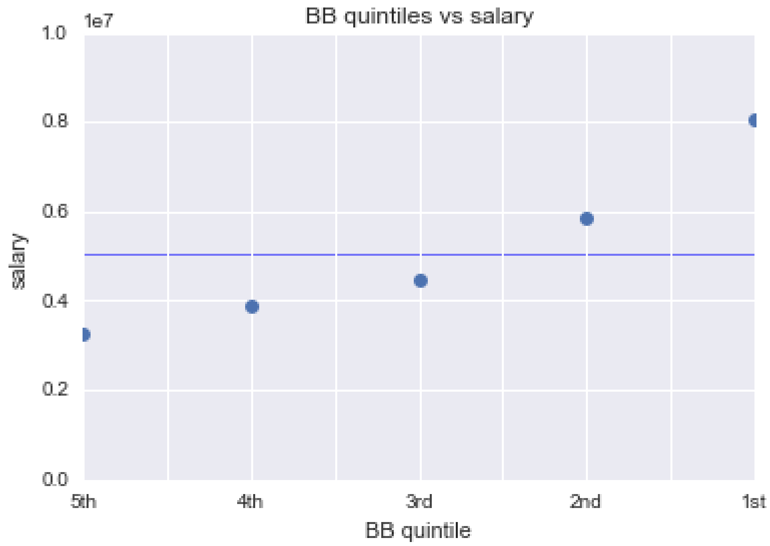
Out[210]: <matplotlib.text.Text at 0x1295bf250>



In [211]:
```
salaryBBbinaxs = batting_n_salaries_last5yrs.groupby('BBbin').mean()['salary
#BAbingroup = batting_n_salaries_last5yrs.groupby('BAbin', as_index=False)
axsBBbin = salaryBBbinaxs.plot(x='BBbin', y='salary', style='o')

axsBBbin.set_ylim(000000,10000000)
axsBBbin.set_xlabel("BB quintile")
axsBBbin.set_ylabel("salary")
axsBBbin.axhline(y=5050966.57435,xmin=0,xmax=3,c="blue",linewidth=0.5,zorder=
axsBBbin.set_title('BB quintiles vs salary')
```

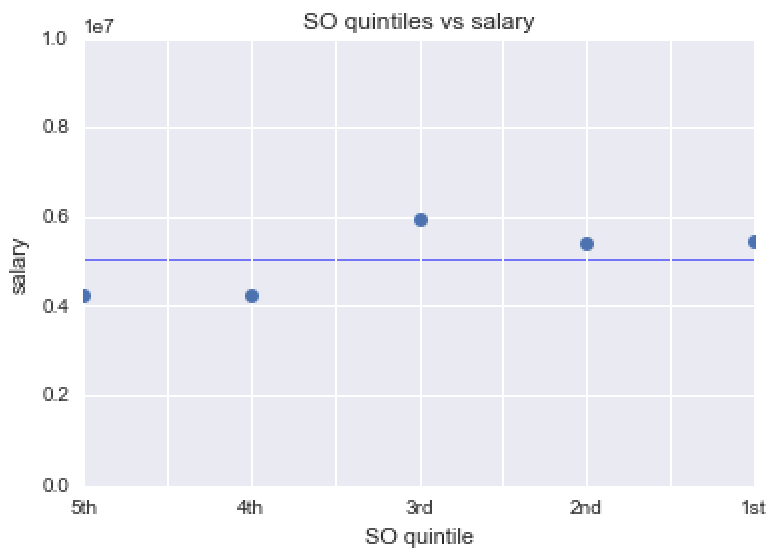
Out[211]: <matplotlib.text.Text at 0x12993ecd0>



In [212]:
```
salarySObinaxs = batting_n_salaries_last5yrs.groupby('SObin').mean()['salary
#BAbingroup = batting_n_salaries_last5yrs.groupby('BAbin', as_index=False)
axsSObin = salarySObinaxs.plot(x='SO', y='salary', style='o')

axsSObin.set_ylim(000000,10000000)
axsSObin.set_xlabel("SO quintile")
axsSObin.set_ylabel("salary")
axsSObin.axhline(y=5050966.57435,xmin=0,xmax=3,c="blue",linewidth=0.5,zorder=
axsSObin.set_title('SO quintiles vs salary')
```

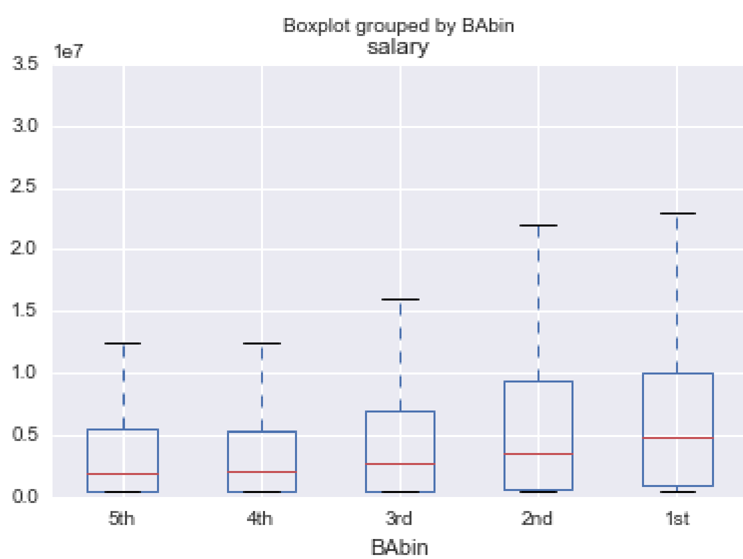
Out[212]: <matplotlib.text.Text at 0x129a57d10>



Use binned values to plot (box plot)

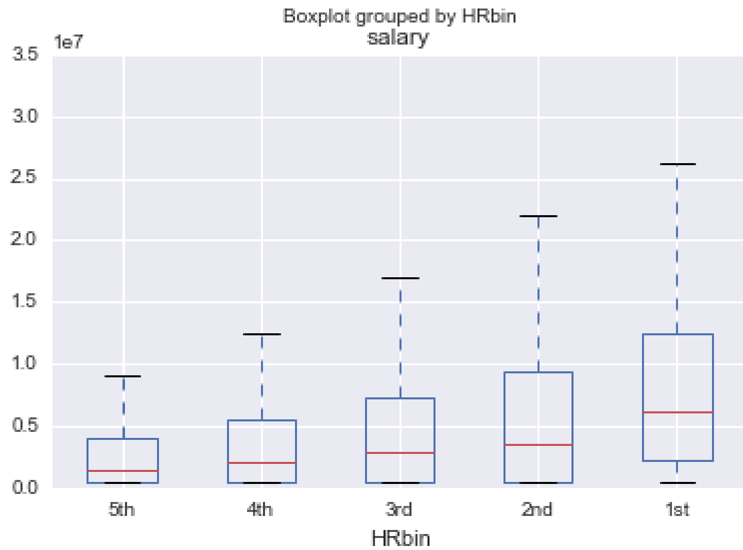
In [213]:
```
batting_n_salaries_last5yrs.boxplot(column='salary', by='BAbin')
```

Out[213]: <matplotlib.axes._subplots.AxesSubplot at 0x12995d610>



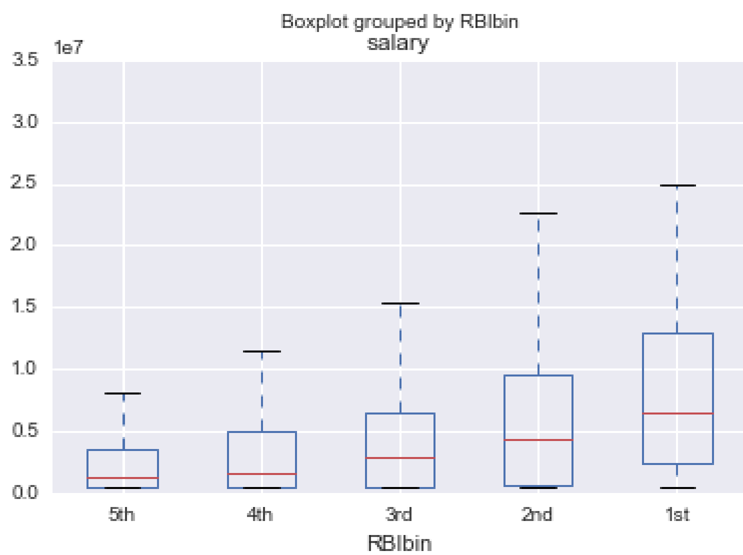
In [214]:
```
batting_n_salaries_last5yrs.boxplot(column='salary', by='HRbin')
```

Out[214]: <matplotlib.axes._subplots.AxesSubplot at 0x129f6ced0>



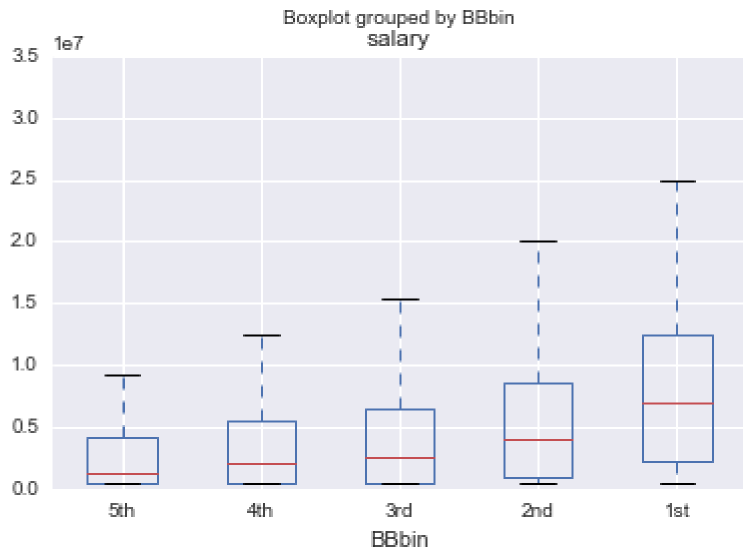
In [215]:
```
batting_n_salaries_last5yrs.boxplot(column='salary', by='RBIbin')
```

Out[215]: <matplotlib.axes._subplots.AxesSubplot at 0x129f6c390>



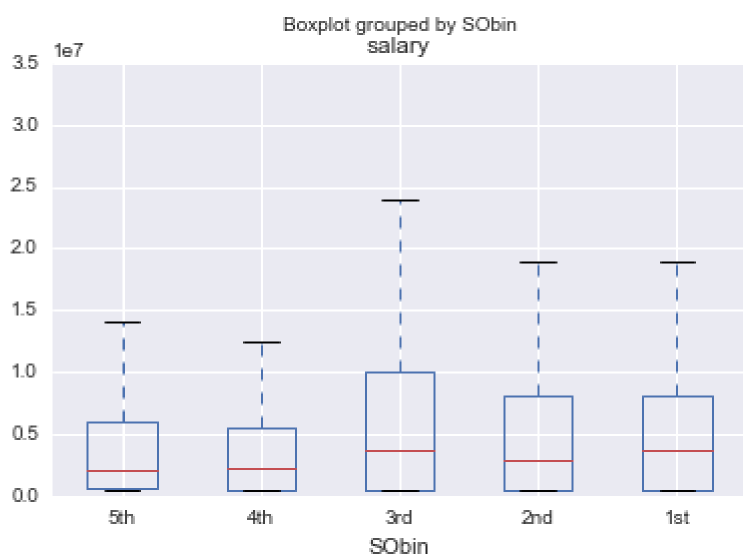
In [216]:
```
batting_n_salaries_last5yrs.boxplot(column='salary', by='BBbin')
```

Out[216]: <matplotlib.axes._subplots.AxesSubplot at 0x12a696b50>



In [217]:
```
batting_n_salaries_last5yrs.boxplot(column='salary', by='SObin')
```

Out[217]: <matplotlib.axes._subplots.AxesSubplot at 0x12e010e50>



Conclusion 2:

> **Consistent with Pearson's R test for average batting stats and avg. salary, players with batting stats in the first and second quintiles consistently placed above the average salary.**

Alternative approach to find correlation

Possible Caveat with the previous correlation: a good BA may decline but the associated salary from said BA does not decline due to the length of the contract signed when the BA was at peak--this will dilute the BA against a stable salary and misrepresent the correlation.

Thus, an alternative approach is to correlate the maximum salary and maximum BA, with the assumption that the max BA will results in max salary, and that it is very unlikely that a random (fluke) high batting average will result in an increased salary--after all, a maintained improved BA is required to increase the salary.

In [218]:

```
#function to find maximum value of a certain player
def max_values(value):
    zz=batting_n_salaries_last5yrs
    return zz.sort_values(by= value, ascending=False).groupby('playerID', as_

#Test function
sorted_batting_salary_max = max_values('salary')
sorted_batting_salary_max.head()
```

Out[218]:

	playerID	yearID	teamID_x	lgID_x	salary	stint	teamID_y	lgID_y	G	AB	R
0	abreubo01	2011	LAA	AL	9000000	1	LAA	AL	142	502.0	54.0
1	abreujo02	2015	CHA	AL	8666000	1	CHA	AL	154	613.0	88.0
2	ackledu01	2013	SEA	AL	2700000	1	SEA	AL	113	384.0	40.0
3	adamsma01	2014	SLN	NL	516000	1	SLN	NL	142	527.0	55.0
4	ahmedni01	2015	ARI	NL	508500	1	ARI	NL	134	421.0	49.0

Find each player's max values

In [219]:
```
sorted_batting_BA_max = max_values('BA')
sorted_batting_HR_max = max_values('HR')
sorted_batting_RBI_max = max_values('RBI')
sorted_batting_SO_max = max_values('SO')
sorted_batting_BB_max = max_values('BB')

max_player_salary = sorted_batting_salary_max['salary']
max_player_BA = sorted_batting_BA_max['BA']
max_player_HR = sorted_batting_HR_max['HR']
max_player_RBI = sorted_batting_RBI_max['RBI']
max_player_SO = sorted_batting_SO_max['SO']
max_player_BB = sorted_batting_BB_max['BB']

Rvalue_max_salary_and_BA = correlation(max_player_salary, max_player_BA)
Rvalue_max_salary_and_HR = correlation(max_player_salary, max_player_HR)
Rvalue_max_salary_and_RBI = correlation(max_player_salary, max_player_RBI)
Rvalue_max_salary_and_BB = correlation(max_player_salary, max_player_BB)
Rvalue_max_salary_and_SO = correlation(max_player_salary, max_player_SO)

print "Pearson's R values (max method)"
print 'max salary and BA:', Rvalue_max_salary_and_BA
print 'max salary and HR:', Rvalue_max_salary_and_HR
print 'max salary and RBI:', Rvalue_max_salary_and_RBI
print 'max salary and BB:', Rvalue_max_salary_and_BB
print 'max salary and SO:', Rvalue_max_salary_and_SO
```

```
Pearson's R values (max method)
max salary and BA: 0.473150726826
max salary and HR: 0.568196862407
max salary and RBI: 0.643511772107
max salary and BB: 0.582868632306
max salary and SO: 0.332729224643
```

In [220]:
```
print len(sorted_batting_salary_max['playerID'])
```

```
573
```

In [221]:
```
#function for obtaining t value for Pearson's R values
def correlation_max_sig_test(r):
    sqrtA = math.sqrt(571)
    sqrtB = math.sqrt(1-(r**2))
    return (r * sqrtA)/sqrtB
```

Calculate t values for max salary/batting stats R values

> ### Null hypothesis is existence of correlation (rho): rho = 0
>
> ### Alternate hypothesis: rho ≠ 0

In [222]:
```
print "t value for Rvalue_max_salary_and_BA = ", correlation_max_sig_test(Rva
print "t value for Rvalue_max_ssalary_and_HR = ", correlation_max_sig_test(Rv
print "t value for Rvalue_max_ssalary_and_RBI = ", correlation_max_sig_test(I
print "t value for Rvalue_max_ssalary_and_BB = ", correlation_max_sig_test(Rv
print "t value for Rvalue_max_ssalary_and_SO = ", correlation_max_sig_test(Rv
```

```
t value for Rvalue_max_salary_and_BA =  12.8336674309
t value for Rvalue_max_ssalary_and_HR =  16.4996107307
t value for Rvalue_max_ssalary_and_RBI =  20.0893342245
t value for Rvalue_max_ssalary_and_BB =  17.1407522197
t value for Rvalue_max_ssalary_and_SO =  8.43115336518
```

Results of t test for max salary/batting stats R values:

> **Null hypothesis is rejected for all R values above since t critical value for 571 degree of freedom**
>
> **for .025 p value(two-tailed test) is between 1.962 and 1.984**
>
> **Thus, all correlations above are significant**

Conclusion 3:

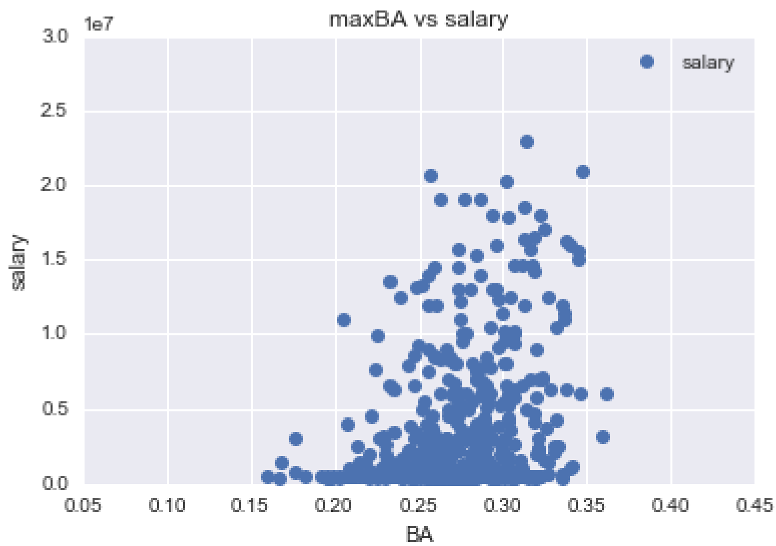
> **Consistent with the previous Pearson's R test for avg. batting stats and max salary (Pearson's R values rank: RBI > HR > BB > BA > SO), this Pearson's R test for max batting stats and max salary also returns similar rankings in Pearson's R values: RBI > BB > HR > BA > SO, with RBI and HR switching places. Using t test, all the correlations are found to be significant (p = 0.05).**

Scatter plots for max values

In [223]:
```
axsmaxBA = sorted_batting_BA_max.plot(x='BA', y='salary', style='o')

axsmaxBA.set_ylim(000000,30000000)
axsmaxBA.set_xlim(0.05,0.45)
axsmaxBA.set_ylabel("salary")
axsmaxBA.set_title('maxBA vs salary')
```

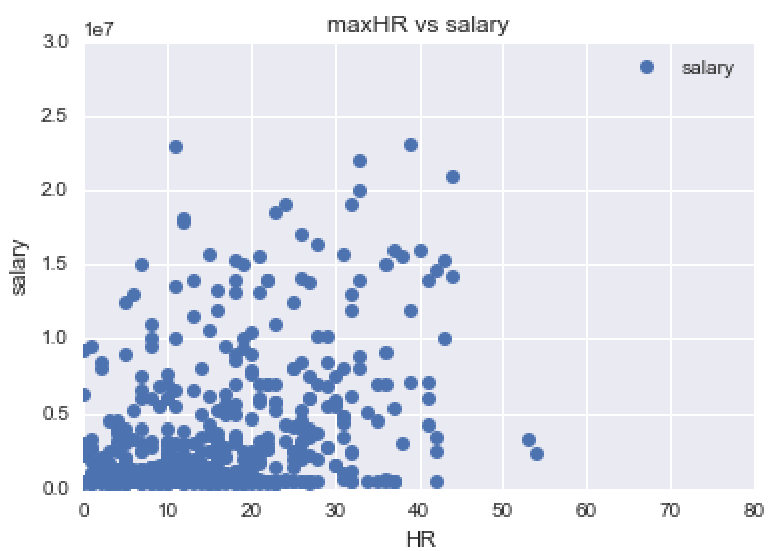
Out[223]: <matplotlib.text.Text at 0x12e425f10>



In [224]:
```
axsmaxHR = sorted_batting_HR_max.plot(x='HR', y='salary', style='o')

axsmaxHR.set_ylim(000000,30000000)
axsmaxHR.set_xlim(0,80)
axsmaxHR.set_ylabel("salary")
axsmaxHR.set_title('maxHR vs salary')
```

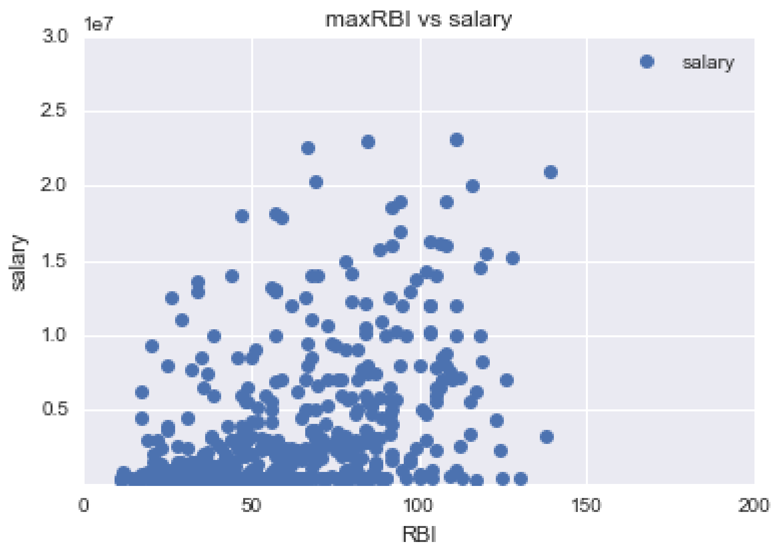
Out[224]: <matplotlib.text.Text at 0x12e688990>



In [225]:
```
axsmaxRBI = sorted_batting_RBI_max.plot(x='RBI', y='salary', style='o')

axsmaxRBI.set_ylim(100000,30000000)
axsmaxRBI.set_xlim(0,200)
axsmaxRBI.set_ylabel("salary")
axsmaxRBI.set_title('maxRBI vs salary')
```

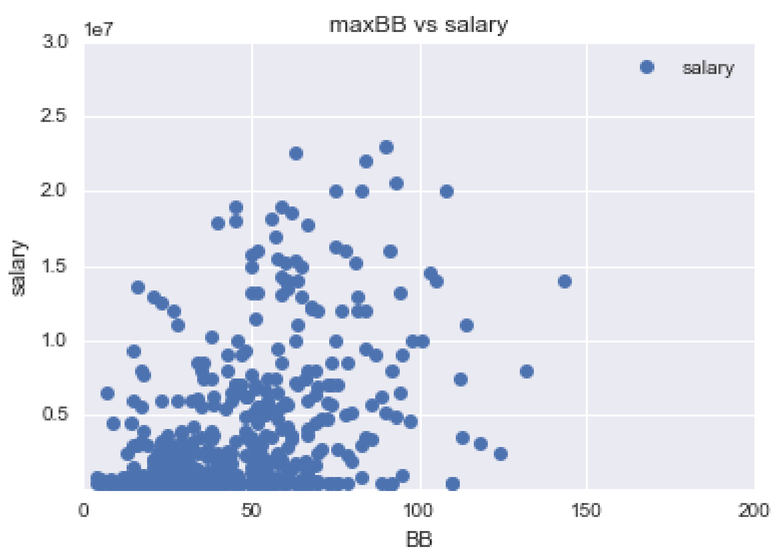
Out[225]: <matplotlib.text.Text at 0x12e7afe50>



In [226]:
```
axsmaxBB = sorted_batting_BB_max.plot(x='BB', y='salary', style='o')

axsmaxBB.set_ylim(100000,30000000)
axsmaxBB.set_xlim(0,200)
axsmaxBB.set_ylabel("salary")
axsmaxBB.set_title('maxBB vs salary')
```

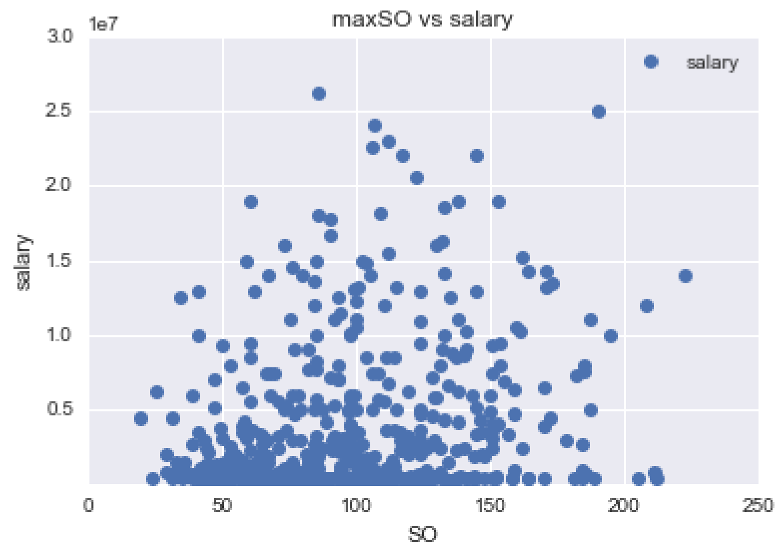
Out[226]: <matplotlib.text.Text at 0x12e8a3190>



In [227]:
```
axsmaxSO = sorted_batting_SO_max.plot(x='SO', y='salary', style='o')

axsmaxSO.set_ylim(100000,30000000)
axsmaxSO.set_xlim(0,250)
axsmaxSO.set_ylabel("salary")
axsmaxSO.set_title('maxSO vs salary')
```

Out[227]: <matplotlib.text.Text at 0x12eace1d0>



As above, binning of batting stats is used to resolve the scatter plot (below).

Create dataframe with player-specific, matching max batting stats and max salary, for plotting binned values.

In [228]:
```
#For some reason I need to put the already existing variable assignment belo
sorted_batting_salary_max = max_values('salary')
sorted_batting_BA_max = max_values('BA')
sorted_batting_HR_max = max_values('HR')
sorted_batting_RBI_max = max_values('RBI')
sorted_batting_SO_max = max_values('SO')
sorted_batting_BB_max = max_values('BB')

#function for replacing max values
def replace_max (df, old, new):
    df[old] = df[new]
    del df[new]
    del df['salary']
    return df

def replace_maxsalary (df, old, new):
    df[old] = df[new]
    del df[new]
    return df

replace_maxsalary (sorted_batting_salary_max, 'maxsalary', 'salary')
replace_max (sorted_batting_BA_max, 'maxBA', 'BA')
replace_max (sorted_batting_HR_max, 'maxHR', 'HR')
replace_max (sorted_batting_RBI_max, 'maxRBI', 'RBI')
replace_max (sorted_batting_SO_max, 'maxSO', 'SO')
replace_max (sorted_batting_BB_max, 'maxBB', 'BB')
sorted_batting_salary_max.head()
```

Out[228]:

	playerID	yearID	teamID_x	lgID_x	stint	teamID_y	lgID_y	G	AB	R	H	2B
0	abreubo01	2011	LAA	AL	1	LAA	AL	142	502.0	54.0	127.0	30.
1	abreujo02	2015	CHA	AL	1	CHA	AL	154	613.0	88.0	178.0	34.
2	ackledu01	2013	SEA	AL	1	SEA	AL	113	384.0	40.0	97.0	18.
3	adamsma01	2014	SLN	NL	1	SLN	NL	142	527.0	55.0	152.0	34.
4	ahmedni01	2015	ARI	NL	1	ARI	NL	134	421.0	49.0	95.0	17.

Merge max salary and max batting stats

In [229]:
```
#function to merge max salary with other max batting matrices dataframe, sep
def merge_max(df):
    return sorted_batting_salary_max.merge(df, on=['playerID'], how='inner')

batting_n_salaries_maxBA_last5yrs = merge_max(sorted_batting_BA_max)
batting_n_salaries_maxHR_last5yrs = merge_max(sorted_batting_HR_max)
batting_n_salaries_maxRBI_last5yrs = merge_max(sorted_batting_RBI_max)
batting_n_salaries_maxSO_last5yrs = merge_max(sorted_batting_SO_max)
batting_n_salaries_maxBB_last5yrs = merge_max(sorted_batting_BB_max)

batting_n_salaries_maxHR_last5yrs.head()
```

Out[229]:

	playerID	yearID_x	teamID_x_x	lgID_x_x	stint_x	teamID_y_x	lgID_y_x	G_x	AB_x	R
0	abreubo01	2011	LAA	AL	1	LAA	AL	142	502.0	54
1	abreujo02	2015	CHA	AL	1	CHA	AL	154	613.0	88
2	ackledu01	2013	SEA	AL	1	SEA	AL	113	384.0	40
3	adamsma01	2014	SLN	NL	1	SLN	NL	142	527.0	55
4	ahmedni01	2015	ARI	NL	1	ARI	NL	134	421.0	49

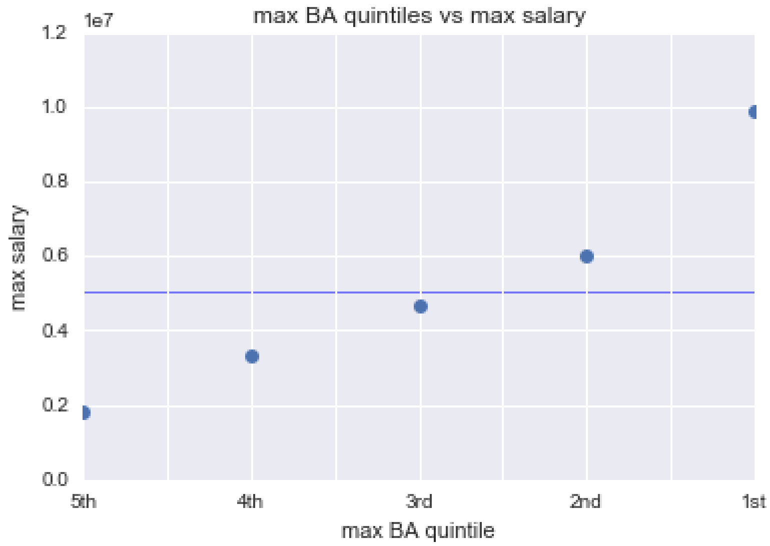
In [230]:
```
#Use binning funciton to bin batting matrices.
batting_n_salaries_maxBA_last5yrs['maxBAbin'] = binning(batting_n_salaries_ma
batting_n_salaries_maxHR_last5yrs['maxHRbin'] = binning(batting_n_salaries_ma
batting_n_salaries_maxRBI_last5yrs['maxRBIbin'] = binning(batting_n_salaries_
batting_n_salaries_maxSO_last5yrs['maxSObin'] = binning(batting_n_salaries_ma
batting_n_salaries_maxBB_last5yrs['maxBBbin'] = binning(batting_n_salaries_ma
```

Use binned values to plot (dot plot)

In [232]:
```
maxsalaryBAbinaxs = batting_n_salaries_maxBA_last5yrs.groupby('maxBAbin').mea
axsmaxBAbin = maxsalaryBAbinaxs.plot(x='maxBAbin', y='maxsalary', style='o')

axsmaxBAbin.set_ylim(000000,12000000)
axsmaxBAbin.set_xlabel("max BA quintile")
axsmaxBAbin.set_ylabel("max salary")
axsmaxBAbin.axhline(y=5050966.57435,xmin=0,xmax=3,c="blue",linewidth=0.5,zor
axsmaxBAbin.set_title('max BA quintiles vs max salary')
```

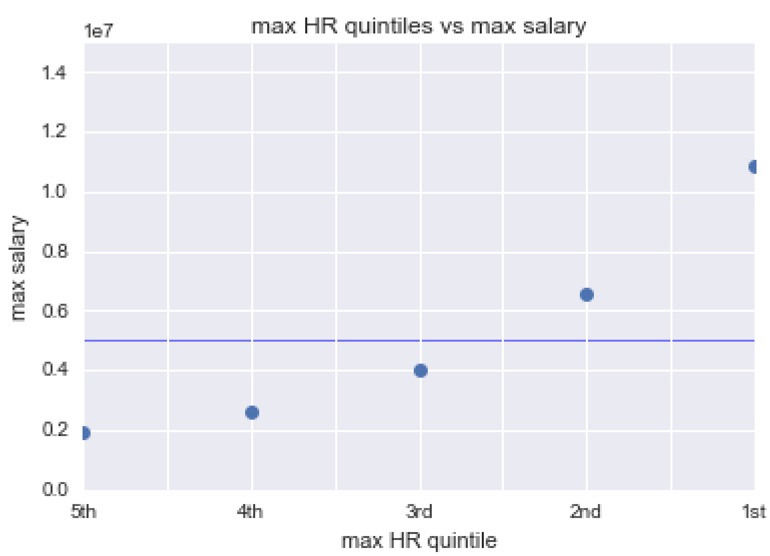
Out[232]: <matplotlib.text.Text at 0x1292d5410>



In [233]:
```
maxsalaryHRbinaxs = batting_n_salaries_maxHR_last5yrs.groupby('maxHRbin').mea
axsmaxHRbin = maxsalaryHRbinaxs.plot(x='maxHRbin', y='maxsalary', style='o')

axsmaxHRbin.set_ylim(000000,15000000)
axsmaxHRbin.set_xlabel("max HR quintile")
axsmaxHRbin.set_ylabel("max salary")
axsmaxHRbin.axhline(y=5050966.57435,xmin=0,xmax=3,c="blue",linewidth=0.5,zor
axsmaxHRbin.set_title('max HR quintiles vs max salary')
```

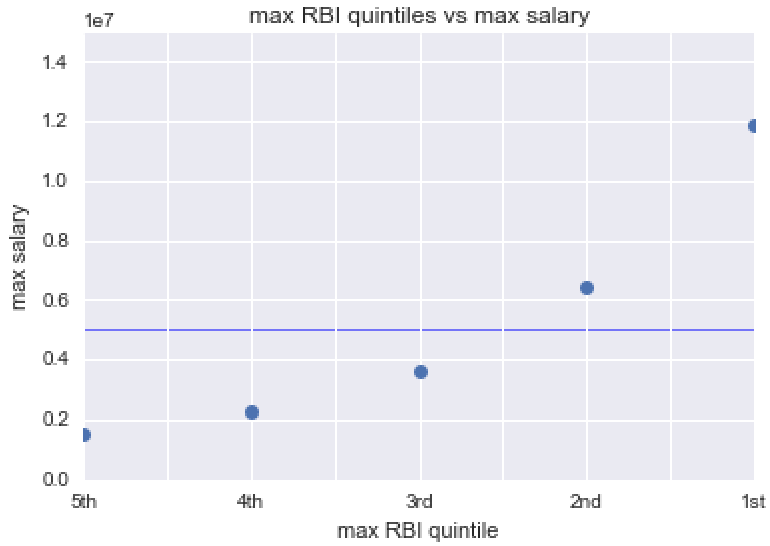
Out[233]: <matplotlib.text.Text at 0x12ef1e250>



In [234]:
```
maxsalaryRBIbinaxs = batting_n_salaries_maxRBI_last5yrs.groupby('maxRBIbin')
axsmaxRBIbin = maxsalaryRBIbinaxs.plot(x='maxRBIbin', y='maxsalary', style='

axsmaxRBIbin.set_ylim(000000,15000000)
axsmaxRBIbin.set_xlabel("max RBI quintile")
axsmaxRBIbin.set_ylabel("max salary")
axsmaxRBIbin.axhline(y=5050966.57435,xmin=0,xmax=3,c="blue",linewidth=0.5,zo
axsmaxRBIbin.set_title('max RBI quintiles vs max salary')
```

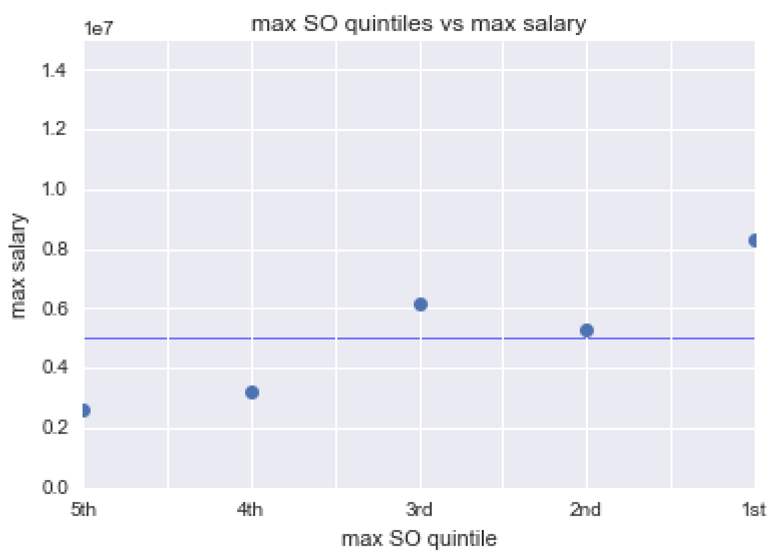
Out[234]: <matplotlib.text.Text at 0x1300f0b10>



In [235]:
```
maxsalarySObinaxs = batting_n_salaries_maxSO_last5yrs.groupby('maxSObin').me
axsmaxSObin = maxsalarySObinaxs.plot(x='maxSObin', y='maxsalary', style='o')

axsmaxSObin.set_ylim(000000,15000000)
axsmaxSObin.set_xlabel("max SO quintile")
axsmaxSObin.set_ylabel("max salary")
axsmaxSObin.axhline(y=5050966.57435,xmin=0,xmax=3,c="blue",linewidth=0.5,zor
axsmaxSObin.set_title('max SO quintiles vs max salary')
```

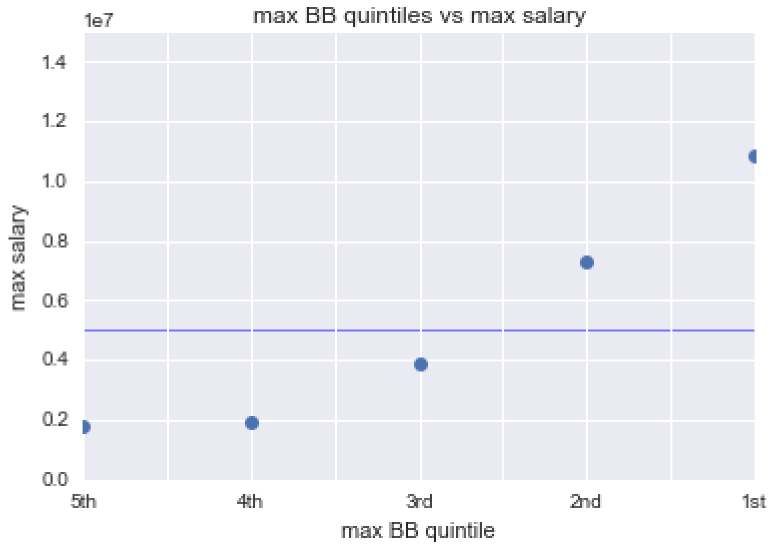
Out[235]: <matplotlib.text.Text at 0x13028cdd0>



In [236]:
```
maxsalaryBBbinaxs = batting_n_salaries_maxBB_last5yrs.groupby('maxBBbin').mea
axsmaxBBbin = maxsalaryBBbinaxs.plot(x='maxBBbin', y='maxsalary', style='o')

axsmaxBBbin.set_ylim(000000,15000000)
axsmaxBBbin.set_xlabel("max BB quintile")
axsmaxBBbin.set_ylabel("max salary")
axsmaxBBbin.axhline(y=5050966.57435,xmin=0,xmax=3,c="blue",linewidth=0.5,zor
axsmaxBBbin.set_title('max BB quintiles vs max salary')
```

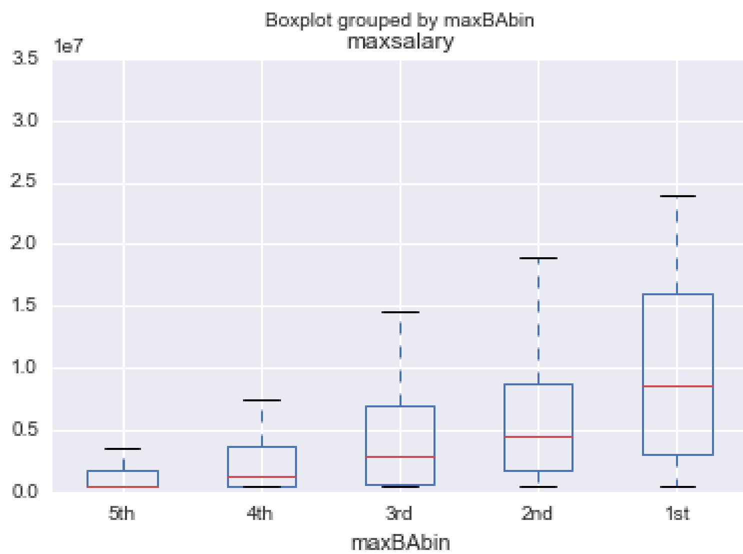
Out[236]: <matplotlib.text.Text at 0x13053a910>



Use binned values to plot (box plot)

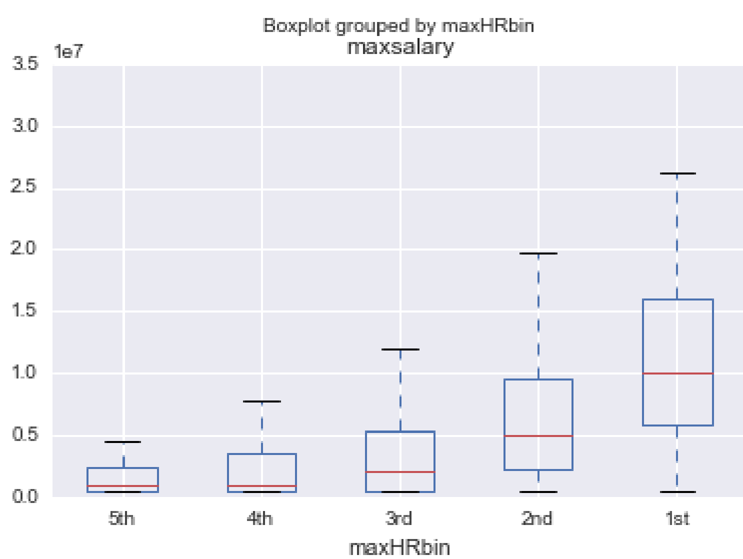
In [237]:
```
#boxplotBAbin = maxsalaryBAbinaxs(['maxsalary','maxBAbin'])
# XXX = batting_n_salaries_maxBA_last5yrs.groupby('maxBAbin').T
# XXX.boxplot(column = 'maxsalary')
# df2 = batting_n_salaries_maxBA_last5yrs.pivot(columns=batting_n_salaries_m
# df2.columns = df2.columns.droplevel()
# df2.boxplot()
#grouped = batting_n_salaries_maxBA_last5yrs['maxsalary'].groupby(level='max
batting_n_salaries_maxBA_last5yrs.boxplot(column='maxsalary', by='maxBAbin')
# data.boxplot(column='2013-08-17',by='SPECIES')
```

Out[237]: <matplotlib.axes._subplots.AxesSubplot at 0x1292f5a90>



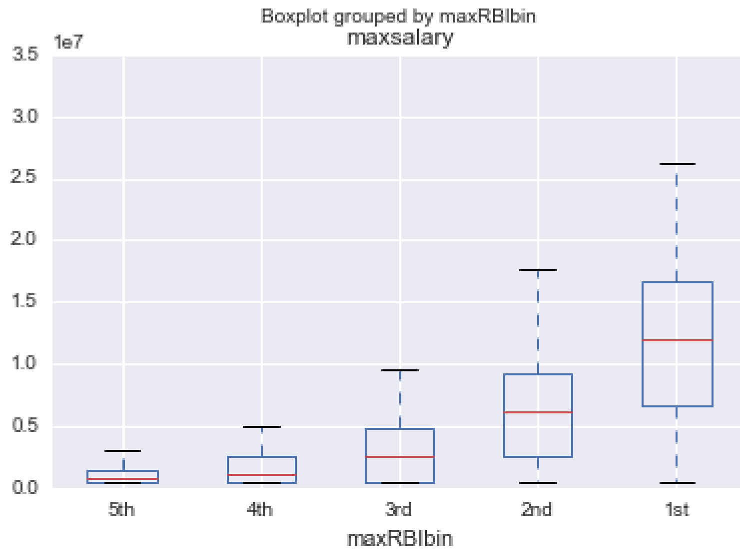
In [238]:
```
batting_n_salaries_maxHR_last5yrs.boxplot(column='maxsalary', by='maxHRbin')
```

Out[238]: <matplotlib.axes._subplots.AxesSubplot at 0x1309cfd10>



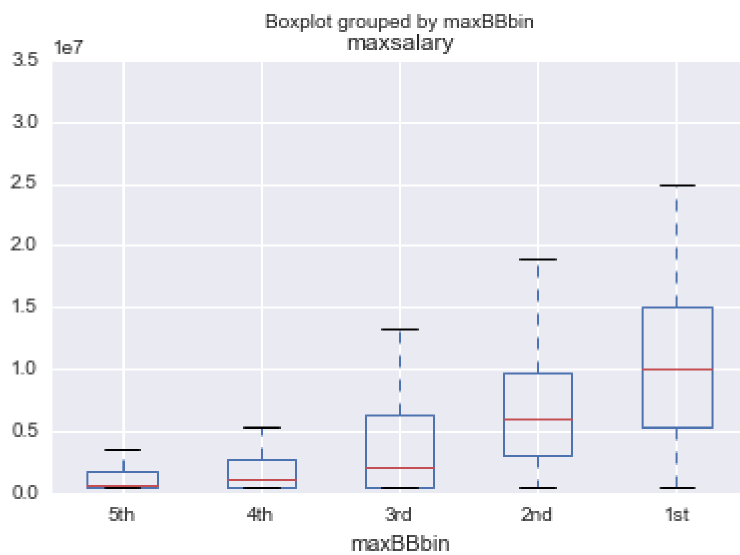
In [239]:
```
batting_n_salaries_maxRBI_last5yrs.boxplot(column='maxsalary', by='maxRBIbin
```

Out[239]: <matplotlib.axes._subplots.AxesSubplot at 0x1309cfc10>



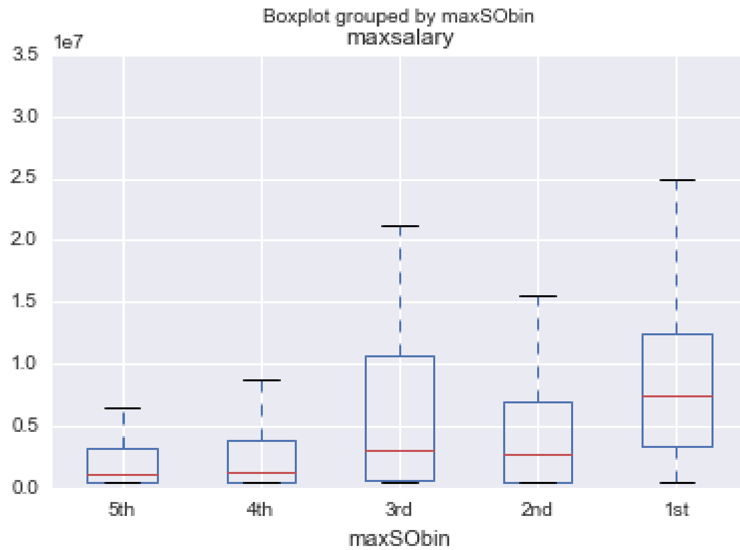
In [240]:
```
batting_n_salaries_maxBB_last5yrs.boxplot(column='maxsalary', by='maxBBbin')
```

Out[240]: <matplotlib.axes._subplots.AxesSubplot at 0x1310990d0>



In [241]:
```
batting_n_salaries_maxSO_last5yrs.boxplot(column='maxsalary', by='maxSObin')
```

Out[241]: <matplotlib.axes._subplots.AxesSubplot at 0x131242d90>



Conclusion 4:

> **Consistent with both 1.) Pearson's R test for max batting stats and max salary, and 2.) binned plots for avg. batting stats/salary, the max batting stats in the first and second quintiles consistently placed in the above max salary.**

Final conclusion:

> **It is reproducibly demonstrated, via binned batting stats vs. salary plot, that higher the Pearson's R test values results in a stronger correlation between the tested batting stat's impact on salary. In addition, all the correlations tested are significant (p = 0.05). However, depending on how the batting stats data are processed for Pearson's R test (in this case, avg. values vs. max values),there may be slight differences in the ranking. This excercise indicates that some stats has a higher correlation with salary amount than other stats. It is also consistent with realworld baseball in that a stat such as strikeouts(SO) has the lowest Pearson's R test values since SO is a negative performance stat. As above, this does not indicate that having higher said stat in isolation will directly result in higher salary, since other stats are not constant for each player while this analysis was performed, as well as unforseen events not detected in our data/tests.**