SITE NUMBER—07144100

SITE NAME—Little Arkansas River near Sedgwick

DATE CREATED—3/18/2013

MODEL DEVELOPMENT DATA PERIOD—5/1/1998 – 9/22/2011

MODEL-CALIBRATION DATASET—All data were collected using U.S. Geological Survey (USGS) protocols and are stored in National Water Information System (NWIS) database. The regression model is based on 162 concurrent measurements of specific conductance and sodium samples collected from 05-01-1998 through 09-22-2011. Samples were collected throughout the range of continuously observed specific conductance conditions. Specific conductance values are time-averaged, approved unit values corresponding with the duration of sample collection. Summary statistics and complete model-calibration dataset are provided. No sodium values were deemed outliers.

MODEL DEVELOPMENT— Regression analysis was done using S-PLUS, R, and a spreadsheet macro that examined specific conductance as an explanatory variable for estimating sodium. Different combinations of untransformed and $\log_{10}$-transformed data were evaluated. Sodium and specific conductance were selected as the best model based on residual plots, model standard percentage error (*MSPE*), adjusted R^2, prediction error sum of squares (PRESS), and Mallow's C_p. Model spreadsheet is archived and can be found at http://nrtwq.usgs.gov/ks for review, and contains all relevant sample data and more in-depth statistical information.

MODEL SUMMARY—Summary of final regression analysis for sodium concentration at site number 07144100.

Specific conductance-based model:

$$\mathbf{\log_{10}(Na) = 1.34 \times \log_{10}(SC) - 2.09}\ ,$$

where

Na = sodium, in milligrams per liter; and

SC = specific conductance, in microsiemens per centimeter at 25 degrees Celsius.

The use of specific conductance as an explanatory variable makes sense both physically and statistically. It makes sense physically because sodium is a major ion that affects the conductivity of water. This correlates well with specific conductance because specific conductance measures the conductivity of water. Specific conductance makes statistical sense as an explanatory variable because it resulted in a model with low Mallow's C_p and PRESS values, and high adjusted R^2 values.

SODIUM RECORD— The record is computed using the regression model in the National Real-Time Water Quality (NRTWQ) website. Data are computed at hourly intervals. The record is complete for the year except as noted. The specific conductance monitor was removed during winter months because of below freezing conditions. A more in-depth description of the water quality record can be found at –

http://nrtwq.usgs.gov/ks

REMARKS—

- Site location, equipment, and other stream-gaging station information can be found in the Site Information Management System (SIMS).

Computed: Aaron King

Reviewed: Patrick Rasmussen

07144100 - Little Ark near Sedgwick - Sodium

Model Form

log(Na) = 1.34 * log(SC) - 2.09

Explanatory variable summary statistics

	log(SC)	SC
Minimum	1.732	54.0
1st Quartile	2.441	276
Median	2.773	593
Mean	2.677	585
3rd Quartile	2.941	871
Maximum	3.126	1340

Notes:

Dependent variable summary statistics

	log(Na)	Na
Minimum	0.1761	1.50
1st Quartile	1.207	16.1
Median	1.626	42.3
Mean	1.496	44.5
3rd Quartile	1.845	70.0
Maximum	2.121	132

Notes:

Model Calibration

Basic Data

Number of Measurements:	162
Standard Error:	0.06333
MSPE (Upper)	+15.7
MSPE (Lower)	-13.57
R^2	0.98
Adj R^2	0.98
Duan BCF:	1.01

Explanatory Variables

Variable	Value	Standard Error
Intercept	-2.09	0.0439
log(SC)	1.34	0.0163

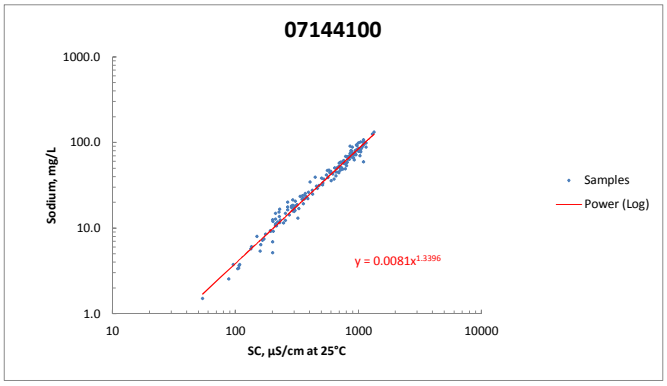
Notes:

Covariance Matrix

	Intercept	log(SC)
Intercept	1	-0.994
log(SC)	-0.994	1

Test Criteria

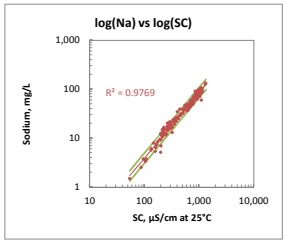
Leverage	Cook's D	DFITS
0.0370	0.792	0.222

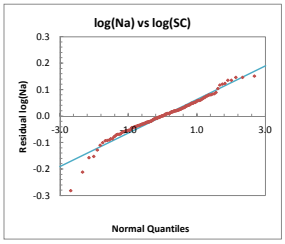


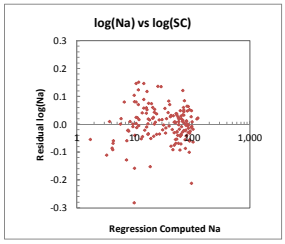
Observations exceeding at least one test criterion

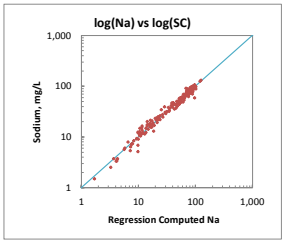
Observation	Observed log(Na)	Predicted log(Na)	Residuals	Standardized Residuals	Studentized Residuals	Leverage	Cook's D	DFITS
4	1.12	1.27	-0.153	-2.43	-2.47	0.00805	0.0239	-0.222
13	0.838	0.996	-0.157	-2.50	-2.55	0.0154	0.0491	-0.319
14	0.405	0.515	-0.110	-1.77	-1.79	0.0417	0.0684	-0.372
17	0.711	0.993	-0.282	-4.49	-4.78	0.0155	0.158	-0.600
33	1.17	1.03	0.147	2.33	2.36	0.0143	0.0394	0.285
44	1.22	1.07	0.151	2.39	2.43	0.0129	0.0374	0.278
52	0.575	0.566	0.00950	0.153	0.153	0.0381	0.000463	0.0303
65	1.19	1.06	0.124	1.97	1.99	0.0131	0.0257	0.229
84	1.30	1.16	0.147	2.33	2.36	0.0104	0.0285	0.242
94	0.176	0.231	-0.0547	-0.894	-0.893	0.0652	0.0278	-0.236
127	0.732	0.859	-0.127	-2.03	-2.05	0.0211	0.0446	-0.302
144	0.533	0.623	-0.0905	-1.45	-1.46	0.0342	0.0375	-0.275
148	0.526	0.613	-0.0863	-1.39	-1.39	0.0349	0.0348	-0.265
152	1.77	1.98	-0.211	-3.36	-3.47	0.0149	0.0855	-0.428

Notes:









Date	SC, µS/cm at 25°C	Streamflow, ft^3/sec	Sodium, mg/L	log(Na)	log(SC)	Regression Computed Na	Residual log(Na)	Normal Quantiles	90% P.I. Lower	90% P.I. Upper
5/1/1998	868	729	80.7	1.91	2.94	70.3	0.060	1.11	55.2	89.5
5/6/1998	803	143	58.3	1.77	2.91	63.3	-0.036	-0.713	49.7	80.6
5/11/1998	911	128	66.0	1.82	2.96	75.0	-0.055	-1.06	58.9	95.5
5/14/1998	322	1947	13.1	1.12	2.51	18.6	-0.153	-2.01	14.6	23.7
5/27/1998	844	100	63.5	1.80	2.93	67.7	-0.028	-0.543	53.2	86.2
6/16/1998	877	43.5	67.6	1.83	2.94	71.3	-0.023	-0.439	56.0	90.7
6/24/1998	598	413	45.9	1.66	2.78	42.7	0.032	0.598	33.5	54.3
7/10/1998	211	1360	11.2	1.05	2.32	10.6	0.025	0.508	8.3	13.5
7/13/1998	316	243	18.8	1.27	2.50	18.2	0.015	0.258	14.3	23.1
7/20/1998	558	44.8	47.1	1.67	2.75	38.9	0.083	1.47	30.6	49.5
8/6/1998	819	28.7	63.7	1.80	2.91	65.0	-0.009	-0.194	51.1	82.8
9/15/1998	877	14.5	80.2	1.90	2.94	71.3	0.051	0.906	56.0	90.7
9/22/1998	201	913	6.89	0.838	2.30	9.90	-0.158	-2.14	7.8	12.6
9/25/1998	88.0	6590	2.54	0.405	1.94	3.28	-0.110	-1.82	2.6	4.2
10/5/1998	108	7490	3.76	0.575	2.03	4.31	-0.059	-1.14	3.4	5.5
10/22/1998	425	104	24.9	1.40	2.63	27.0	-0.035	-0.674	21.2	34.4
11/5/1998	200	8776	5.14	0.711	2.30	9.84	-0.282	-2.68	7.7	12.5
12/4/1998	729	222	50.8	1.71	2.86	55.6	-0.039	-0.795	43.7	70.8
1/12/1999	1101	113	94.4	1.98	3.04	96.7	-0.010	-0.226	75.9	123.0
2/1/1999	306	4676	20.7	1.32	2.49	17.4	0.076	1.30	13.7	22.1
2/19/1999	1041	119	78.9	1.90	3.02	89.7	-0.056	-1.08	70.4	114.1
3/16/1999	1337	110	132	2.12	3.13	125	0.022	0.439	98.5	159.6
3/23/1999	1095	98.1	102	2.01	3.04	95.9	0.027	0.526	75.4	122.1
4/7/1999	404	1651	34.5	1.54	2.61	25.2	0.136	2.01	19.8	32.1
4/16/1999	200	5410	12.5	1.10	2.30	9.84	0.104	1.62	7.7	12.5
5/5/1999	802	239	53.8	1.73	2.90	63.2	-0.070	-1.34	49.7	80.5
5/24/1999	211	1664	12.7	1.10	2.32	10.6	0.080	1.34	8.3	13.5
6/18/1999	300	410	17.0	1.23	2.48	16.9	0.002	0.023	13.3	21.5
6/21/1999	220	2223	11.8	1.07	2.34	11.2	0.024	0.473	8.8	14.2
7/20/1999	176	3521	8.47	0.928	2.25	8.29	0.009	0.163	6.5	10.5
8/3/1999	149	4238	7.97	0.902	2.17	6.63	0.080	1.38	5.2	8.4

8/19/1999	924	88.8	72.8	1.86	2.97	76.4	-0.021	-0.372	60.0	97.3
9/28/1999	212	1915	14.9	1.17	2.33	10.6	0.146	2.14	8.4	13.5
2/9/2000	1113	84.4	96.3	1.98	3.05	98.1	-0.008	-0.163	77.0	124.8
3/7/2000	286	1151	18.2	1.26	2.46	15.9	0.059	1.06	12.5	20.2
3/28/2000	254	4559	14.9	1.17	2.41	13.6	0.041	0.753	10.6	17.2
5/19/2000	1064	98.6	87.3	1.94	3.03	92.3	-0.024	-0.473	72.5	117.5
5/31/2000	456	203	30.8	1.49	2.66	29.7	0.016	0.290	23.3	37.8
6/28/2000	364	1165	24.2	1.38	2.56	21.9	0.043	0.795	17.2	27.9
7/28/2000	353	160	22.3	1.35	2.55	21.1	0.025	0.490	16.5	26.8
8/16/2000	749	23.5	59.0	1.77	2.87	57.7	0.010	0.194	45.3	73.4
9/8/2000	846	19.1	69.4	1.84	2.93	67.9	0.009	0.179	53.4	86.4
9/25/2000	855	20.9	74.4	1.87	2.93	68.9	0.034	0.654	54.1	87.7
10/26/2000	228	6524	16.6	1.22	2.36	11.7	0.151	2.68	9.2	14.9
11/8/2000	514	82.5	33.8	1.53	2.71	34.8	-0.013	-0.274	27.4	44.3
12/4/2000	1086	46.2	92.6	1.97	3.04	94.9	-0.011	-0.242	74.5	120.8
3/14/2001	336	1932	23.4	1.37	2.53	19.7	0.075	1.27	15.5	25.1
4/13/2001	565	415	39.0	1.59	2.75	39.5	-0.006	-0.147	31.1	50.3
4/26/2001	982	98.2	83.1	1.92	2.99	82.9	0.001	0.008	65.1	105.5
5/8/2001	660	155	49.5	1.70	2.82	48.7	0.007	0.085	38.3	62.0
6/4/2001	292	1050	18.4	1.27	2.47	16.3	0.052	0.930	12.8	20.8
6/6/2001	96.0	8962	3.76	0.575	1.98	3.68	0.009	0.147	2.9	4.7
6/23/2001	165	4251	7.23	0.859	2.22	7.60	-0.022	-0.422	6.0	9.7
7/11/2001	811	49.1	58.7	1.77	2.91	64.2	-0.039	-0.753	50.4	81.7
8/2/2001	765	24.4	57.0	1.76	2.88	59.3	-0.017	-0.306	46.6	75.5
8/28/2001	788	31.2	69.1	1.84	2.90	61.7	0.049	0.883	48.5	78.6
9/20/2001	135	4178	6.09	0.785	2.13	5.81	0.020	0.405	4.6	7.4
10/31/2001	853	27.3	70.9	1.85	2.93	68.7	0.014	0.242	53.9	87.4
1/10/2002	1040	36.4	101	2.00	3.02	89.5	0.052	0.954	70.3	114.0
2/21/2002	1100	42.0	108	2.03	3.04	96.5	0.049	0.860	75.8	122.9
4/9/2002	961	93.5	93.5	1.97	2.98	80.6	0.065	1.17	63.3	102.5
4/22/2002	265	1480	17.6	1.25	2.42	14.3	0.089	1.56	11.3	18.3
5/22/2002	422	142	27.7	1.44	2.63	26.8	0.015	0.274	21.0	34.0
6/6/2002	388	244	22.0	1.34	2.59	23.9	-0.036	-0.733	18.8	30.4
6/13/2002	226	5868	15.4	1.19	2.35	11.6	0.124	1.82	9.1	14.8
7/9/2002	720	29.6	51.4	1.71	2.86	54.7	-0.027	-0.508	43.0	69.6
8/15/2002	744	750	48.8	1.69	2.87	57.2	-0.069	-1.30	44.9	72.8
9/19/2002	720	15.2	58.9	1.77	2.86	54.7	0.032	0.616	43.0	69.6
12/18/2002	1300	41.1	126	2.10	3.11	121	0.019	0.322	94.8	153.6
3/20/2003	292	6285	21.4	1.33	2.47	16.3	0.117	1.68	12.8	20.8
4/17/2003	1150	69.9	98.4	1.99	3.06	103	-0.018	-0.322	80.5	130.5
4/23/2003	642	296	50.3	1.70	2.81	46.9	0.030	0.580	36.9	59.7
5/14/2003	369	1709	25.3	1.40	2.57	22.4	0.054	0.978	17.6	28.4
5/29/2003	479	193	31.5	1.50	2.68	31.7	-0.003	-0.070	24.9	40.3
6/11/2003	656	96.5	45.0	1.65	2.82	48.3	-0.031	-0.598	37.9	61.5
6/24/2003	1000	57.0	84.4	1.93	3.00	85.0	-0.003	-0.085	66.7	108.1
7/30/2003	894	7.73	73.8	1.87	2.95	73.1	0.004	0.054	57.4	93.1
9/3/2003	265	578	16.4	1.22	2.42	14.3	0.058	1.03	11.3	18.3
10/14/2003	193	1077	9.20	0.964	2.29	9.38	-0.008	-0.179	7.4	11.9
12/11/2003	1120	46.2	101	2.00	3.05	98.9	0.009	0.132	77.7	125.9
3/9/2004	212	1819	10.7	1.03	2.33	10.6	0.003	0.039	8.4	13.5
3/30/2004	999	292	79.3	1.90	3.00	84.9	-0.029	-0.561	66.7	108.0
4/26/2004	986	50.6	82.5	1.92	2.99	83.4	-0.005	-0.116	65.5	106.1
5/13/2004	265	1153	20.1	1.30	2.42	14.3	0.147	2.33	11.3	18.3
5/26/2004	1040	49.7	83.3	1.92	3.02	89.5	-0.031	-0.616	70.3	114.0
6/16/2004	788	56.1	55.9	1.75	2.90	61.7	-0.043	-0.860	48.5	78.6
6/22/2004	273	1042	14.2	1.15	2.44	14.9	-0.022	-0.388	11.7	19.0
7/27/2004	133	5855	5.70	0.756	2.12	5.70	0.000	-0.023	4.5	7.2
1/27/2005	348	172	21.7	1.34	2.54	20.7	0.021	0.422	16.2	26.3
3/23/2005	227	5855	13.7	1.14	2.36	11.7	0.070	1.20	9.2	14.8
5/10/2005	587	203	44.3	1.65	2.77	41.6	0.027	0.543	32.7	53.0
5/27/2005	305	743	16.0	1.20	2.48	17.3	-0.034	-0.654	13.6	22.0
6/6/2005	291	1957	15.9	1.20	2.46	16.3	-0.010	-0.210	12.8	20.7
6/9/2005	54.0	11797	1.50	0.176	1.73	1.70	-0.055	-1.03	1.3	2.2
8/31/2005	363	112	21.9	1.34	2.56	21.9	0.001	-0.008	17.2	27.8
2/9/2006	872	32.5	76.3	1.88	2.94	70.7	0.033	0.635	55.6	90.0
5/2/2006	743	122	60.2	1.78	2.87	57.1	0.023	0.456	44.8	72.6
6/8/2006	1000	25.5	98.5	1.99	3.00	85.0	0.064	1.14	66.7	108.1
6/26/2006	286	114	17.4	1.24	2.46	15.9	0.040	0.733	12.5	20.2
7/27/2006	693	3.12	44.4	1.65	2.84	52.0	-0.068	-1.27	40.8	66.2
8/15/2006	658	6.99	40.8	1.61	2.82	48.5	-0.075	-1.38	38.1	61.7
8/23/2006	576	15.2	47.7	1.68	2.76	40.6	0.070	1.24	31.9	51.7
9/27/2006	751	6.99	57.6	1.76	2.88	57.9	-0.002	-0.054	45.5	73.7
1/10/2007	873	13.8	78.6	1.90	2.94	70.8	0.045	0.816	55.6	90.2
2/5/2007	974	15.2	91.6	1.96	2.99	82.0	0.048	0.838	64.4	104.4
3/12/2007	708	19.1	58.3	1.77	2.85	53.5	0.037	0.693	42.0	68.1
3/21/2007	698	51.0	57.3	1.76	2.84	52.5	0.038	0.713	41.2	66.8
3/27/2007	446	164	39.3	1.59	2.65	28.8	0.135	1.91	22.6	36.7
4/2/2007	167	2886	7.35	0.866	2.22	7.73	-0.022	-0.405	6.1	9.8
4/18/2007	231	861	12.4	1.09	2.36	11.9	0.017	0.306	9.4	15.2
7/11/2007	161	1927	6.42	0.808	2.21	7.36	-0.059	-1.11	5.8	9.4
8/16/2007	686	59.3	45.2	1.66	2.84	51.3	-0.055	-1.00	40.3	65.3
9/6/2007	952	25.5	72.6	1.86	2.98	79.5	-0.040	-0.816	62.5	101.2
11/26/2007	815	28.9	67.7	1.83	2.91	64.6	0.020	0.388	50.8	82.2
12/6/2007	906	29.5	70.6	1.85	2.96	74.4	-0.023	-0.456	58.5	94.8
12/13/2007	300	2740	15.6	1.19	2.48	16.9	-0.036	-0.693	13.3	21.5
3/6/2008	305	979	18.1	1.26	2.48	17.3	0.019	0.339	13.6	22.0
4/14/2008	465	484	29.1	1.46	2.67	30.5	-0.020	-0.355	23.9	38.8
5/29/2008	216	2895	10.6	1.03	2.33	10.9	-0.012	-0.258	8.6	13.9
6/30/2008	356	877	19.3	1.29	2.55	21.3	-0.043	-0.838	16.7	27.1
8/5/2008	708	24.9	50.2	1.70	2.85	53.5	-0.028	-0.526	42.0	68.1
4/6/2009	669	187	50.6	1.70	2.83	49.6	0.009	0.116	39.0	63.1
4/13/2009	548	851	41.8	1.62	2.74	38.0	0.042	0.774	29.8	48.3
4/28/2009	202	9190	12.0	1.08	2.31	9.97	0.081	1.42	7.8	12.7
6/16/2009	511	661	32.1	1.51	2.71	34.6	-0.032	-0.635	27.2	44.0
7/30/2009	255	523	12.3	1.09	2.41	13.6	-0.044	-0.906	10.7	17.3
9/9/2009	159	3141	5.39	0.732	2.20	7.23	-0.128	-1.91	5.7	9.2
9/24/2009	246	333	11.5	1.06	2.39	13.0	-0.053	-0.954	10.2	16.5
11/3/2009	327	328	16.9	1.23	2.52	19.0	-0.051	-0.930	14.9	24.2
11/19/2009	780	65.0	49.2	1.69	2.89	60.9	-0.093	-1.68	47.9	77.5
12/1/2009	921	54.7	62.4	1.80	2.96	76.1	-0.086	-1.51	59.8	96.9
12/17/2009	1030	58.7	70.2	1.85	3.01	88.4	-0.100	-1.74	69.4	112.5
1/6/2010	1150	94.5	88.5	1.95	3.06	103	-0.064	-1.20	80.5	130.5
1/19/2010	1040	79.7	77.9	1.89	3.02	89.5	-0.061	-1.17	70.3	114.0
2/4/2010	949	63.9	71.7	1.86	2.98	79.2	-0.043	-0.883	62.2	100.8
2/23/2010	997	69.3	81.8	1.91	3.00	84.6	-0.015	-0.290	66.5	107.7
3/10/2010	712	547	47.7	1.68	2.85	53.9	-0.053	-0.978	42.3	68.6
3/11/2010	619	11111	42.8	1.63	2.79	44.7	-0.019	-0.339	35.1	56.9
4/14/2010	1040	52.7	83.6	1.92	3.02	89.5	-0.030	-0.580	70.3	114.0
4/23/2010	601	228	35.8	1.55	2.78	43.0	-0.079	-1.42	33.7	54.7

5/13/2010	349	544	23.8	1.38	2.54	20.7	0.060	1.08	16.3	26.4
6/9/2010	170	2448	7.47	0.873	2.23	7.91	-0.025	-0.490	6.2	10.1
6/10/2010	228	3345	11.6	1.06	2.36	11.7	-0.005	-0.132	9.2	14.9
6/13/2010	106	7905	3.41	0.533	2.03	4.20	-0.091	-1.56	3.3	5.3
6/14/2010	107	15162	3.64	0.561	2.03	4.26	-0.068	-1.24	3.3	5.4
6/15/2010	192	6480	9.32	0.969	2.28	9.31	0.000	-0.039	7.3	11.9
6/16/2010	203	4806	9.17	0.962	2.31	10.0	-0.039	-0.774	7.9	12.8
7/6/2010	104	13387	3.36	0.526	2.02	4.10	-0.086	-1.47	3.2	5.2
8/19/2010	632	60.8	37.2	1.57	2.80	46.0	-0.092	-1.62	36.1	58.5
8/25/2010	524	770	37.4	1.57	2.72	35.8	0.020	0.372	28.1	45.5
11/16/2010	500	262	38.3	1.58	2.70	33.6	0.057	1.00	26.4	42.7
1/19/2011	1100	83.3	59.3	1.77	3.04	96.5	-0.212	-2.33	75.8	122.9
3/7/2011	759	50.8	61.4	1.79	2.88	58.7	0.019	0.355	46.1	74.7
3/16/2011	806	48.0	68.1	1.83	2.91	63.6	0.029	0.561	50.0	81.0
4/6/2011	957	37.6	82.1	1.91	2.98	80.1	0.011	0.210	62.9	102.0
4/18/2011	942	32.8	80.6	1.91	2.97	78.4	0.012	0.226	61.6	99.8
5/2/2011	937	28.8	77.1	1.89	2.97	77.9	-0.004	-0.101	61.2	99.1
6/7/2011	691	21.9	52.5	1.72	2.84	51.8	0.006	0.070	40.7	65.9
6/21/2011	890	110	88.3	1.95	2.95	72.7	0.085	1.51	57.1	92.5
6/22/2011	854	46.2	90.9	1.96	2.93	68.8	0.121	1.74	54.0	87.5
8/15/2011	376	25.5	23.3	1.37	2.58	22.9	0.007	0.101	18.0	29.2
9/22/2011	391	42.9	26.3	1.42	2.59	24.2	0.037	0.674	19.0	30.7