# Determining the Trend of Chum Population Dynamics in Area 5 and Measuring the Success of Small Hatcheries for Stock Assistance Year 3 and 4 (2008-2009)

**Prepared for: Northern Boundary and Transboundary Rivers Restoration and Enhancement Fund**

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## EXECUTIVE SUMMARY

This project has now completed its third (2008) and a limited fourth year (2009) due to budget constraints which focuses on the contribution of small hatcheries such as the Oona River hatchery to increase chum salmon populations in small coastal systems such as the Kumealon River. Habitat measurements were taken within the Kumealon system in 2006 using standard fisheries techniques for determination of spawning area for chum redds and to aid in quantifying the maximum potential population of chum spawners. (Refer to the reports ***Determining the Trend of Chum Dynamics in Area 5 and Measuring the Success of Small Hatcheries for Year 1(2006) and Year 2 (2007)*** and for maps and measurements).

Reviewing historical chum records from the 1950's to the present indicates that there has been lots of variation in chum populations in Kumealon but there has been a downward trend. Declines in population can be attributed to various activities such as the past logging activity in the Kumealon watershed, bycatch in the Area 4 sockeye and pink commercial fishery and Area 5 seine pink fishery and the possible effects of climate change. Historical records showed that the decadal average in the Kumealon system for returning chum spawners in the 1950's was 725 and the historical mean from 1950-1989 was 370 with a maximum reported 1500 spawners in the system. The recent records show that the 1990-2001 average was 67 chums with 80 chums reported in the system in 2006 and in 2007 there was just over 500 chums reported in the system but very few pinks. We believe that there was a huge mortality on chum salmon in 2007 because of the lack of pinks in the system and the large bear population as we could see very few morts on our visual surveys.

In 2008 we took approximately 3000 eggs from broodstock takes in the Kumealon system during the month of July and August. There were very few chum salmon returning to the system and the combined number of morts and live fish that were observed in the Kumeleon system was 27 chums. Most of the eggs taken for broodstock in 2008 were from partial spawned females and we had to separate the eggs out at the hatchery because of concerns with Trichodina.. Approximately 800 fry had their right ventral fin clipped and they were returned to the Kumealon system on April 25 2009.

Total chum spawning area in the Kumealon system at this present time was 2166 m2. Using the criteria of average chum redd size, consecutive redds per coupling and amount of area needed for coupling we calculated that the system could accommodate up to 850 spawners in its present condition **(Refer to 2006 Report for habitat measurements).** Determination of hatchery success will be conducted on visual surveys of returning spawners that have been clipped in relation to overall returning spawners. Since 95% of chum spawners in Kumealon system are 3 year old chums (personnel communication with Brian Spilsted FAO North Coast biologist) we would expect the majority of the 2007 clipped frys to return as adults in 2010.

Temperature loggers were placed in the Oona River Hatchery, Kumealon main flow and the Kumealon gravel. The daily temperature data for 2007-2008 like 2006-2007 shows a

distinct difference in water temperature as the Kumealon system is a much more warmer than Oona River and therefore results in more accumulated thermal units (ATU's) for faster development of the chum fry.

DNA and scale analysis shows that the majority of the chum salmon that were sampled (91.3%) in 2007 were 3 year old chums.

## INTRODUCTION

There appears to be a continuous downward trend in the observed chum salmon stocks in Area 5 from the 1950's to their present population numbers in the first decade of this new millennium according to the Fisheries Salmon Escapement database. The Oona River Resource Association (ORRA) in partnership with the Stock Assessment Branch of the North Coast Fisheries and Oceans decided it would be a beneficial to investigate the spawning potential of a typical chum bearing system in Area 5 alongside using a small hatchery for increasing chum salmon stocks in this system.

The Kumealon system was chosen because it has a small standing chum population, easy access by boat, clarity of water for observing chum populations and in the vicinity of the operating area of the Oona River hatchery for acquiring broodstock. The biologist and fish technicians of ORRA are familiar with the Kumealon system and are experienced in acquiring broodstock and are knowledgeable in hatchery techniques for the successful incubation of eggs to the fry stage.

The project has maintained five objectives:

1. To sample a major chum bearing system in Area 5 for quantifying spawning potential in this system. **Habitat assessment done in 2006**.
2. To enumerate the in migrating adult chum and dead spawners for the duration of their migration into the Kumealon system. Resident time of the chum spawners has been determined by the observation of different coloured elastic bands placed on the peduncle of spawners to observe their spatial and temporal movement. Coverage on average was every 2-3 days and the coordination of visits with the FAO streamwalker allowed even better coverage.
3. To collect DNA samples of chum salmon for FAO Fisheries stock assessment for building up DNA profiles for North Coast streams**. (This has been done from 2006-2009)**
4. To collect broodstock from the Kumealon system and transfer the fertilized eggs into incubation trays in the hatchery at Oona River. These eggs would be monitored for the next six months for disease and water quality to ensure a good egg-fry survival rate. **(Chum broodstock has been collected each year and we were able to do a limited broodstock take in 2009 due to the budget restraints)**
5. In the early spring, the emergent chums would be held for a short time at the hatchery and then returned back to the Kumealon river for imprinting. Before they are released they

would be fin-clipped in order to differentiate the returning adult chum as wild or enhanced stock.

All objectives have been met in this project as shown in the results and discussion of this report. Drawbacks would have been the lack of chum spawners in 2008 and the lack of funding in 2009.

**METHODS**

The North Coast has many river systems but most of these systems are not clear because of the tannic in the water. Kumealon was chosen as the target river because the water clarity for observing in migrating fish and distinguishing the different species is excellent. It also has good historical records for chum presence and it has a small standing crop of spawners. The system has some damage to its spawning habitat from logging in the past and the estimation of the potential of chum spawners is based on spawning area in its present condition. It is approximately 12 nautical miles from Oona River and there is a good trail (1.5km) from the estuary into the main river system. Access on certain stages of the tide (high slack water) through the rapids allows the use of a small skiff for movement into the lower part of the river that flows into a salt lagoon. We use the skiff through the rapids when we are returning the clipped fry to the Kumealon river.

The collection of broodstock is accomplished by the use of small mesh barrier nets on the lower and upper target areas where chum salmon can be visually seen. We try to get our broodstock in the last part of July and early part of August as the main pink salmon in migration is towards the middle and last part of August. We use a larger 152mm mesh net to catch the chum salmon for easier release that reduces stress and helps in very little bycatch of the smaller pink salmon.

We tried to catch at least 3 males to one female for the purpose of genetic integrity. All males after obtaining some milt or immature females were released and tagged by using different coloured elastic band on their peduncle for determining resident time. We ensured that all fish were in good condition before release. All chums that were caught had a small clip from the operculum for a DNA sample which was put in a vial containing 30% ethanol. Scales samples and hypural and fork lengths were also taken during sampling.

Mature female chums that were captured were stripped of their eggs and the unfertilized eggs were put into separate containers. Milt from the males were placed in small whirlpak or ziplock bags and kept cool in a small cooler and taken back to the Oona River hatchery. We timed it that no more than 3 hours would elapse from the time we took the first eggs or milt to arriving at the hatchery in Oona River. At the hatchery, the eggs were fertilized using at least a 3:1 ratio of males to females and then the fertilized eggs were transported to the incubation trays. The eggs were washed in a solution of Ovadine (10ml in 10 liters of water) for protection against fungus and bacterial infections

The fertilized eggs were monitored during the winter from the egg to fry swim up stage and a technician was paid some hours each week to monitor water quality and pick any dead eggs from the trays and record the temperature in the tank .The fry at swim up stage

were fed using a feed timer that distributed Ewos micro feed using a standard formula calibrated to chum juveniles.

Transportation of the fry was done by putting the fry in a large insulated tote filled with water and supplied with an air stone running on 12VDC battery power. The tote was placed in a large skiff and towed to Kumealon by a larger vessel. The skiff then was taken through the tidal rapids at high slack water to utilize the bigger tides for allowing further movement up the river for release of the fry.

A thermal temperature logger (StowAway Tidbit TB3237) was placed in the water flow at the Oona River hatchery and two temperature loggers in the spawning area of Kumealon in both the main river flow and one buried in the gravel. The data from the tidbit was downloaded using the BoxCar 3.7 for Windows Program. The interval for readings was 4 times a day and the 4 temperatures were averaged to give an average daily temperature.

## RESULTS

### Monitoring of Chum In Migration and Acquiring Broodstock for 2008

The movement of chums into the Kumealon system begins in late July and spawning usually is over by the first part of September. The acquisition of broodstock is much easier in the beginning of their in migration as you do not have to worry about the bycatch of pinks. In 2008 we took our first chum eggs on August 1st and our last eggs on August 16th and in 2009 we were able to take chum eggs starting on August 3rd and our last broodstock take was on August 11th 2009.

### Incubation of Chum Eggs and Development Time for Eyed Stage, Hatch Stage and Swim up stage.

| Salmon species | To Eyed Stage(ATU's) | To Hatched Stage (ATU's) | To Swim Up Stage (ATU's) |
|---|---|---|---|
| **Coho** | 217-237 | 448-475 | 777-829 |
| ***Chum*** | ***217-250*** | ***498-546*** | ***845-1126*** |
| **Chinook** | 242-258 | 512-526 | 825-1029 |
| **Pink** | 224-257 | 545-662 | 868-1034 |
| **Sockeye** | 236-257 | 614-694 | 943-1088 |

**Table 1. Average Accumulated Thermal Units (ATU's) for Developmental Stages of the Different Salmonids.**

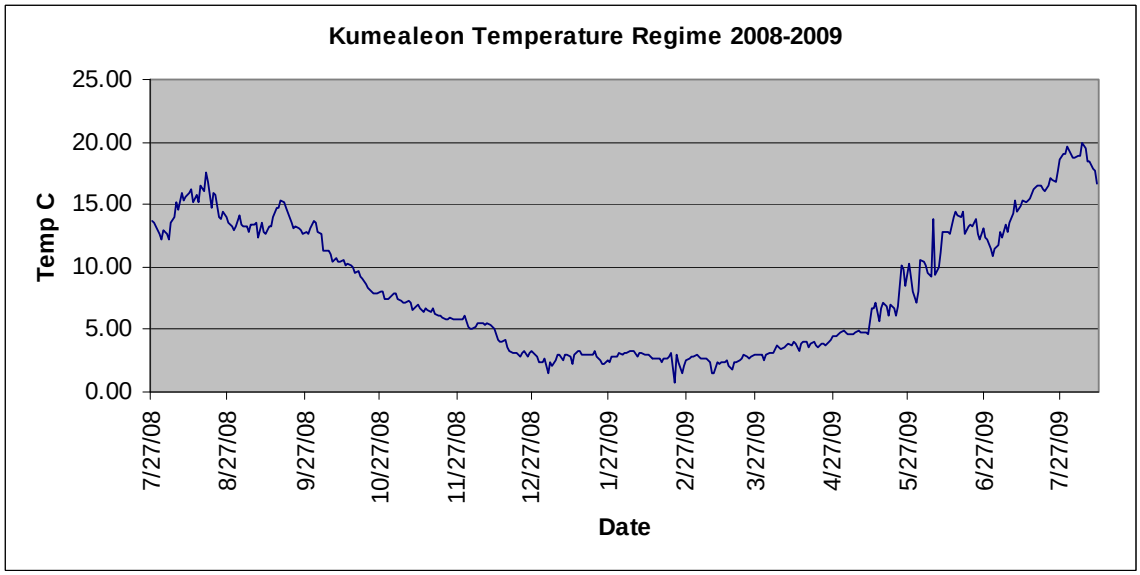


**Fig 1. Average Daily Temperature of Kumealeon Stream from July 27 2008 to Aug 10 2009**

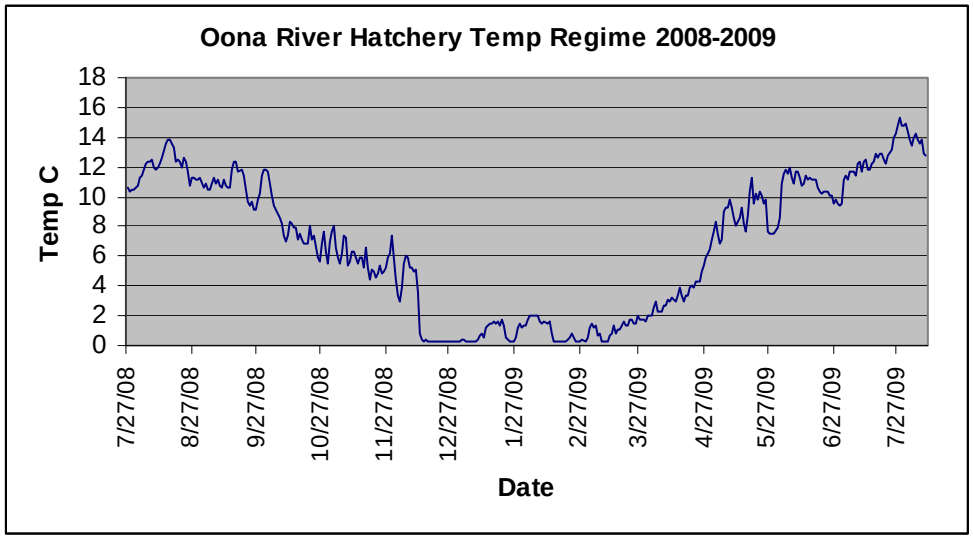


**Fig. 2 Average Daily Temperature recorded at Hatchery in Oona River from July 27 2008 to Aug 10 2009.**

Figure 1 and Figure 2 are both charts that were generated from the data from the BoxCar Program which takes the input of data from the optical reader. The recordings are then exported into Excel where the data can be manipulated to generate charts. Figure 1 shows that the Kumealeon watershed is buffered by the lake because of the less volatility of the water temperature and is presented by a smooth curve. Fig 2 shows the temp recordings from Oona River which expresses more volatility with some extreme cold temperatures

near zero degrees Celsius during the period of late November to early March. This is reflected in the difference of the ATU's shown in Table 3 in the Appendix.

## DNA and Scale Analysis

Brian Spilsted of Fisheries and Oceans sent us the breakdown of the DNA and scale analysis for the scale and DNA samples taken in 2007. and the table below is a summary of the results;

| **Kumealon River 2007 Area 5 North Coast Division Grenville Channel** | | | | | | |
|---|---|---|---|---|---|---|
| **Containers 52772,56245,64333,70243,79837 Gear: Unknown** | | | | | | |
| **Sample Dates: 2007-08-01 to 2007-08-31** | | | | | | |
| **Age Distribution** | | | | | | |
| | **Species** | **European** | **Gilbert** | **Brood** | **Frequency** | **Percent** |
| | | | **Rich** | **Year** | | |
| | **Chum** | 02 | 31 | 2004 | 3 | 4.3% |
| | **Chum** | 03 | 41 | 2005 | 64 | 91.4% |
| | **Chum** | 04 | 51 | 2006 | 3 | 4.3% |
| | | | | **Total** | **70** | **100%** |

**Table 2 Summary of DNA and Scale Analysis for Kumealeon for 2007 from Brian Spilsted Biologist North Coast Division of Fisheries and Oceans.**

The information on the DNA and scale analysis has allowed us to concentrate more on the 3 year old fish as they represent the majority of the chum returning to the Kumealeon system. So the 2006 broodstock represent the 2010 adult chum migrants. However in 2011 we should start picking up some of the four year old class.

## DISCUSSION

This project is examining the use of small hatcheries in doing stock assistance for chum salmon on the North Coast of British Columbia. The preliminary study of 2006 showed that there are some necessary questions that have to be investigated by using a small scale approach to understand why chum salmon streams in Area 5 are slowing losing their population base when compared with the historical records of the 1950's and onward in the Fisheries and Oceans Salmon Escapement Database.

The recorded number of chum salmon that was estimated by both this project's crew and the FAO Streamwalker was 80 chum in 2006 but Kumealon was exceptional in 2007 with over 500 estimated spawners in the systems. In 2008 there were only 27 chum recorded in the Kumealon system and the 2009 chum count was over a 1000 chums.

The approximate 3000 eggs that were put originally into the incubation trays at the Oona River hatchery in 2008 resulted in approximately 800 clipped fish released back into the Kumealon system in April 2009. These fry were released at an average of .6-.8 grams which is about double what the wild chum smolts would weigh when they out migrate. The temperature loggers in both Kumealon and Oona River show a striking difference in temperature regimes between the two systems. One temperature logger was put in the

main river  The temperature logger in Oona River did not function properly but the water temperature in the hatchery tank was taken daily by a technician. The comparison of the the graph shows that Oona River and the Kumealon  temperature regimes do differ as the Kumealon system has a gradual slope with very little spiking which is attributed to the buffering action of the large lake at its headwaters. The Oona system is not a lake fed system and results in more spiking in its temperature profile. The Accumulated Thermal

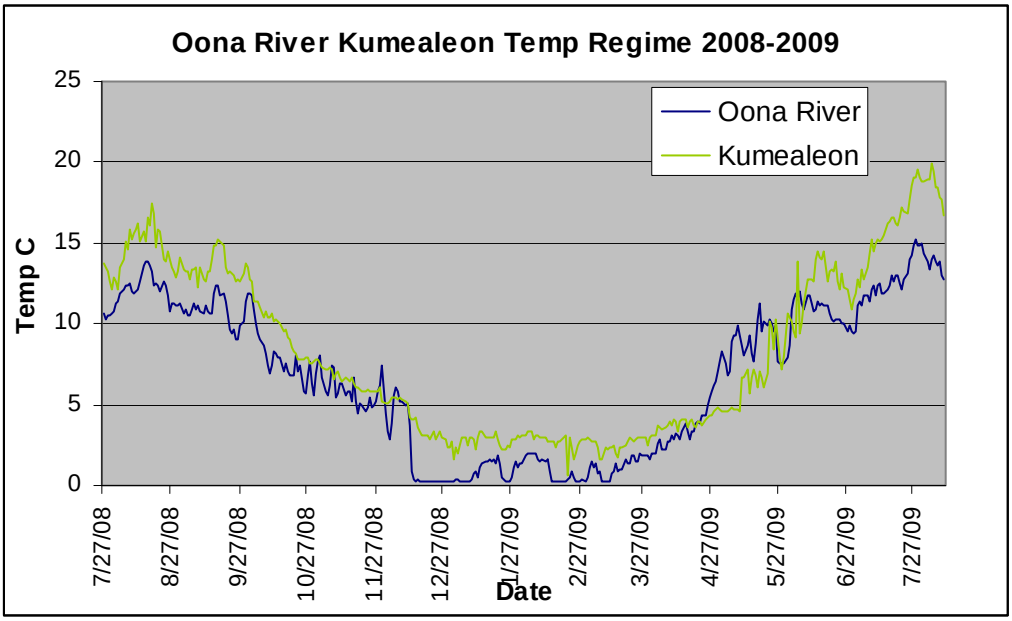


**Fig 3 Comparison of Water Temperature in Kumealon and Oona River Watersheds from July 29 2008 to Aug 10 2009.**

Units were quite similar for Oona River and the Main Flow of Kumealon for the period of July 29 2007 to April 7$^{th\ 2008}$ with Oona River recording 1682 and the Main Flow of Kumealon 1685. However, in 2008-2009 in the same period of July 27$^{th}$ 2008 to April 7$^{th}$ 2009 the temperature recordings from the tidbits gave a count of 1338 ATU's for Oona River and 1803 ATU's for Kumealeon that represents a difference of 24%. In Fig 3 you can see that there was a cold snap of weather from late November to early March with very cold temperature in Oona River but buffered temperature from the lake in Kumealeon.
The first reported chum at the swimup stage at the Oona River hatchery was in early November but the bulk of the fry emergence was the middle of February to late March.

## RECOMMENDATIONS AND CONCLUSIONS

We had some extra funding $4500.00 for 2008-2009 for investigating the out migration of chum smolts for their timing in relation to prediction of the outmigration based on the recorded ATU's. However there were very few chums in the system in 2008 and so the output would have been very little for doing any type of investigation. The cancellation of the Northern Fund for 2009 prompted us to ask the Northern Fund if that funding could be used for doing a limited project in 2009.

However, we still believe it is important to investigate the chum fry usage of the estuary and also to sample some of these smolts for doing stomach analysis to see what they are feeding on while they reside in the estuary. Plankton tows and other benthic sampling should be done to associate the availability of food sources for what may be present in their stomachs.

These are some of the areas that will be investigated for understanding the population dynamics of this system and how this may apply to other chum bearing systems in Area 5.

## APPENDIX

**Table 3 Readouts from Temperature Tidbits in Kumealon and Oona River and the Accumulated Thermal Units (ATU's) for 2008-2009.**

| Date | Oona River Temp C | OonaRiver ATU's | Kumealeon Temp C | Kumealeon ATU's |
|---|---|---|---|---|
| 7/27/08 | 10.63 | 11 | 13.70 | 14 |
| 7/28/08 | 10.33 | 21 | 13.54 | 27 |
| 7/29/08 | 10.48 | 31 | 13.24 | 40 |
| 7/30/08 | 10.48 | 42 | 12.62 | 53 |
| 7/31/08 | 10.63 | 53 | 12.14 | 65 |
| 8/1/08 | 10.79 | 63 | 12.93 | 78 |
| 8/2/08 | 11.25 | 75 | 12.62 | 91 |
| 8/3/08 | 11.41 | 86 | 12.14 | 103 |
| 8/4/08 | 11.87 | 98 | 13.54 | 116 |
| 8/5/08 | 12.18 | 110 | 14.01 | 130 |
| 8/6/08 | 12.33 | 122 | 15.11 | 146 |
| 8/7/08 | 12.33 | 135 | 14.63 | 160 |
| 8/8/08 | 12.49 | 147 | 15.89 | 176 |
| 8/9/08 | 12.02 | 159 | 15.26 | 191 |
| 8/10/08 | 11.87 | 171 | 15.58 | 207 |
| 8/11/08 | 12.02 | 183 | 15.89 | 223 |
| 8/12/08 | 12.18 | 195 | 16.21 | 239 |
| 8/13/08 | 12.64 | 208 | 15.11 | 254 |
| 8/14/08 | 13.57 | 222 | 15.74 | 270 |
| 8/15/08 | 13.88 | 235 | 15.11 | 285 |
| 8/16/08 | 13.88 | 249 | 16.53 | 302 |
| 8/17/08 | 13.57 | 263 | 16.06 | 318 |
| 8/18/08 | 13.26 | 276 | 17.49 | 335 |
| 8/19/08 | 12.33 | 288 | 16.85 | 352 |
| 8/20/08 | 12.49 | 301 | 14.78 | 367 |
| 8/21/08 | 12.33 | 313 | 15.89 | 383 |
| 8/22/08 | 12.02 | 325 | 15.74 | 398 |
| 8/23/08 | 12.64 | 338 | 14.01 | 412 |
| 8/24/08 | 12.33 | 350 | 13.85 | 426 |
| 8/25/08 | 11.72 | 362 | 14.47 | 441 |
| 8/26/08 | 10.79 | 373 | 14.01 | 455 |

| | | | | |
|---|---|---|---|---|
| 8/27/08 | 11.25 | 384 | 13.54 | 468 |
| 8/28/08 | 11.25 | 395 | 13.24 | 481 |
| 8/29/08 | 11.1 | 406 | 12.93 | 494 |
| 8/30/08 | 11.1 | 417 | 13.24 | 508 |
| 8/31/08 | 11.25 | 429 | 14.16 | 522 |
| 9/1/08 | 10.63 | 439 | 13.39 | 535 |
| 9/2/08 | 10.94 | 450 | 13.24 | 548 |
| 9/3/08 | 10.48 | 461 | 13.24 | 562 |
| 9/4/08 | 10.48 | 471 | 12.77 | 574 |
| 9/5/08 | 10.94 | 482 | 13.39 | 588 |
| 9/6/08 | 11.25 | 493 | 13.39 | 601 |
| 9/7/08 | 10.94 | 504 | 13.54 | 615 |
| 9/8/08 | 11.1 | 515 | 12.30 | 627 |
| 9/9/08 | 10.79 | 526 | 13.54 | 641 |
| 9/10/08 | 10.63 | 537 | 12.77 | 653 |
| 9/11/08 | 11.1 | 548 | 12.62 | 666 |
| 9/12/08 | 10.79 | 559 | 13.24 | 679 |
| 9/13/08 | 10.63 | 569 | 13.24 | 692 |
| 9/14/08 | 10.63 | 580 | 14.01 | 706 |
| 9/15/08 | 11.87 | 592 | 14.79 | 721 |
| 9/16/08 | 12.33 | 604 | 14.79 | 736 |
| 9/17/08 | 12.33 | 617 | 15.26 | 751 |
| 9/18/08 | 11.72 | 628 | 15.11 | 766 |
| 9/19/08 | 11.87 | 640 | 14.79 | 781 |
| 9/20/08 | 11.41 | 652 | 13.54 | 795 |
| 9/21/08 | 10.48 | 662 | 13.08 | 808 |
| 9/22/08 | 9.71 | 672 | 13.24 | 821 |
| 9/23/08 | 9.4 | 681 | 13.16 | 834 |
| 9/24/08 | 9.71 | 691 | 12.98 | 847 |
| 9/25/08 | 9.09 | 700 | 12.62 | 860 |
| 9/26/08 | 9.09 | 709 | 12.77 | 873 |
| 9/27/08 | 9.86 | 719 | 12.62 | 885 |
| 9/28/08 | 10.17 | 729 | 13.08 | 898 |
| 9/29/08 | 11.41 | 740 | 13.70 | 912 |
| 9/30/08 | 11.87 | 752 | 13.54 | 926 |
| 10/1/08 | 11.87 | 764 | 12.77 | 938 |
| 10/2/08 | 11.72 | 776 | 12.62 | 951 |
| 10/3/08 | 10.94 | 787 | 11.37 | 962 |
| 10/4/08 | 10.02 | 797 | 11.37 | 974 |
| 10/5/08 | 9.4 | 806 | 11.37 | 985 |
| 10/6/08 | 9.09 | 815 | 11.06 | 996 |
| 10/7/08 | 8.63 | 824 | 10.44 | 1007 |
| 10/8/08 | 8.17 | 832 | 10.76 | 1017 |
| 10/9/08 | 7.41 | 840 | 10.44 | 1028 |
| 10/10/08 | 6.94 | 847 | 10.44 | 1038 |
| 10/11/08 | 7.41 | 854 | 10.60 | 1049 |
| 10/12/08 | 8.33 | 862 | 10.13 | 1059 |
| 10/13/08 | 8.17 | 870 | 10.29 | 1069 |
| 10/14/08 | 7.87 | 878 | 10.13 | 1079 |
| 10/15/08 | 7.87 | 886 | 9.98 | 1089 |

| | | | | |
|---|---|---|---|---|
| 10/16/08 | 7.09 | 893 | 9.51 | 1099 |
| 10/17/08 | 7.56 | 901 | 9.66 | 1108 |
| 10/18/08 | 7.09 | 908 | 9.19 | 1118 |
| 10/19/08 | 6.79 | 915 | 9.04 | 1127 |
| 10/20/08 | 6.79 | 922 | 8.58 | 1135 |
| 10/21/08 | 6.79 | 928 | 8.28 | 1144 |
| 10/22/08 | 8.02 | 936 | 8.12 | 1152 |
| 10/23/08 | 7.09 | 943 | 7.82 | 1160 |
| 10/24/08 | 7.41 | 951 | 7.82 | 1167 |
| 10/25/08 | 5.86 | 957 | 7.82 | 1175 |
| 10/26/08 | 5.7 | 962 | 7.97 | 1183 |
| 10/27/08 | 6.79 | 969 | 7.97 | 1191 |
| 10/28/08 | 7.71 | 977 | 7.51 | 1199 |
| 10/29/08 | 6.32 | 983 | 7.51 | 1206 |
| 10/30/08 | 5.54 | 989 | 7.66 | 1214 |
| 10/31/08 | 6.94 | 996 | 7.82 | 1222 |
| 11/1/08 | 7.71 | 1003 | 7.82 | 1229 |
| 11/2/08 | 8.02 | 1011 | 7.51 | 1237 |
| 11/3/08 | 6.63 | 1018 | 7.35 | 1244 |
| 11/4/08 | 5.86 | 1024 | 7.19 | 1251 |
| 11/5/08 | 5.54 | 1029 | 7.19 | 1259 |
| 11/6/08 | 6.17 | 1036 | 7.35 | 1266 |
| 11/7/08 | 7.41 | 1043 | 7.19 | 1273 |
| 11/8/08 | 7.25 | 1050 | 6.57 | 1280 |
| 11/9/08 | 5.39 | 1056 | 6.88 | 1287 |
| 11/10/08 | 5.7 | 1061 | 7.04 | 1294 |
| 11/11/08 | 6.32 | 1068 | 6.73 | 1300 |
| 11/12/08 | 6.32 | 1074 | 6.42 | 1307 |
| 11/13/08 | 5.54 | 1080 | 6.73 | 1314 |
| 11/14/08 | 5.86 | 1085 | 6.57 | 1320 |
| 11/15/08 | 5.86 | 1091 | 6.42 | 1327 |
| 11/16/08 | 5.23 | 1096 | 6.73 | 1333 |
| 11/17/08 | 6.63 | 1103 | 6.26 | 1340 |
| 11/18/08 | 5.23 | 1108 | 6.11 | 1346 |
| 11/19/08 | 4.46 | 1113 | 6.11 | 1352 |
| 11/20/08 | 5.08 | 1118 | 5.95 | 1358 |
| 11/21/08 | 4.92 | 1123 | 5.79 | 1364 |
| 11/22/08 | 4.62 | 1127 | 5.79 | 1369 |
| 11/23/08 | 4.77 | 1132 | 5.95 | 1375 |
| 11/24/08 | 5.39 | 1138 | 5.79 | 1381 |
| 11/25/08 | 4.77 | 1142 | 5.79 | 1387 |
| 11/26/08 | 4.92 | 1147 | 5.79 | 1393 |
| 11/27/08 | 5.23 | 1153 | 5.79 | 1398 |
| 11/28/08 | 5.86 | 1158 | 5.79 | 1404 |
| 11/29/08 | 6.17 | 1165 | 6.11 | 1410 |
| 11/30/08 | 7.41 | 1172 | 5.17 | 1415 |
| 12/1/08 | 4.46 | 1176 | 5.02 | 1421 |
| 12/2/08 | 3.37 | 1180 | 5.02 | 1426 |
| 12/3/08 | 2.9 | 1183 | 5.17 | 1431 |
| 12/4/08 | 3.84 | 1187 | 5.48 | 1436 |

| | | | | |
|---|---|---|---|---|
| 12/5/08 | 5.54 | 1192 | 5.48 | 1442 |
| 12/6/08 | 6.01 | 1198 | 5.48 | 1447 |
| 12/7/08 | 5.86 | 1204 | 5.33 | 1452 |
| 12/8/08 | 5.23 | 1209 | 5.48 | 1458 |
| 12/9/08 | 5.23 | 1214 | 5.33 | 1463 |
| 12/10/08 | 4.92 | 1219 | 5.17 | 1468 |
| 12/11/08 | 5.08 | 1224 | 5.02 | 1473 |
| 12/12/08 | 3.68 | 1228 | 4.23 | 1478 |
| 12/13/08 | 0.85 | 1229 | 4.08 | 1482 |
| 12/14/08 | 0.37 | 1229 | 4.08 | 1486 |
| 12/15/08 | 0.21 | 1229 | 4.23 | 1490 |
| 12/16/08 | 0.37 | 1230 | 3.61 | 1494 |
| 12/17/08 | 0.21 | 1230 | 3.29 | 1497 |
| 12/18/08 | 0.21 | 1230 | 3.14 | 1500 |
| 12/19/08 | 0.21 | 1230 | 3.14 | 1503 |
| 12/20/08 | 0.21 | 1231 | 3.14 | 1506 |
| 12/21/08 | 0.21 | 1231 | 2.82 | 1509 |
| 12/22/08 | 0.21 | 1231 | 3.14 | 1512 |
| 12/23/08 | 0.21 | 1231 | 3.29 | 1516 |
| 12/24/08 | 0.21 | 1232 | 2.82 | 1518 |
| 12/25/08 | 0.21 | 1232 | 3.14 | 1522 |
| 12/26/08 | 0.21 | 1232 | 3.29 | 1525 |
| 12/27/08 | 0.21 | 1232 | 2.98 | 1528 |
| 12/28/08 | 0.21 | 1232 | 2.82 | 1531 |
| 12/29/08 | 0.21 | 1233 | 2.35 | 1533 |
| 12/30/08 | 0.21 | 1233 | 2.35 | 1535 |
| 12/31/08 | 0.21 | 1233 | 2.67 | 1538 |
| 1/1/09 | 0.21 | 1233 | 1.56 | 1540 |
| 1/2/09 | 0.37 | 1234 | 2.35 | 1542 |
| 1/3/09 | 0.37 | 1234 | 2.03 | 1544 |
| 1/4/09 | 0.21 | 1234 | 2.51 | 1547 |
| 1/5/09 | 0.21 | 1234 | 2.98 | 1550 |
| 1/6/09 | 0.21 | 1235 | 2.98 | 1552 |
| 1/7/09 | 0.21 | 1235 | 2.51 | 1555 |
| 1/8/09 | 0.21 | 1235 | 2.98 | 1558 |
| 1/9/09 | 0.37 | 1235 | 2.98 | 1561 |
| 1/10/09 | 0.69 | 1236 | 2.82 | 1564 |
| 1/11/09 | 0.85 | 1237 | 2.19 | 1566 |
| 1/12/09 | 0.53 | 1237 | 2.98 | 1569 |
| 1/13/09 | 1.17 | 1239 | 3.29 | 1572 |
| 1/14/09 | 1.33 | 1240 | 3.29 | 1576 |
| 1/15/09 | 1.48 | 1241 | 2.98 | 1579 |
| 1/16/09 | 1.48 | 1243 | 2.98 | 1581 |
| 1/17/09 | 1.64 | 1245 | 2.98 | 1584 |
| 1/18/09 | 1.48 | 1246 | 2.98 | 1587 |
| 1/19/09 | 1.64 | 1248 | 2.98 | 1590 |
| 1/20/09 | 1.33 | 1249 | 3.29 | 1594 |
| 1/21/09 | 1.8 | 1251 | 2.82 | 1597 |
| 1/22/09 | 1.33 | 1252 | 2.51 | 1599 |
| 1/23/09 | 0.53 | 1253 | 2.19 | 1601 |

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|---|---|---|---|---|
| 1/24/09 | 0.21 | 1253 | 2.19 | 1603 |
| 1/25/09 | 0.21 | 1253 | 2.51 | 1606 |
| 1/26/09 | 0.21 | 1253 | 2.35 | 1608 |
| 1/27/09 | 0.53 | 1254 | 2.82 | 1611 |
| 1/28/09 | 1.17 | 1255 | 2.82 | 1614 |
| 1/29/09 | 1.48 | 1256 | 2.82 | 1617 |
| 1/30/09 | 1.17 | 1258 | 3.14 | 1620 |
| 1/31/09 | 1.33 | 1259 | 2.98 | 1623 |
| 2/1/09 | 1.33 | 1260 | 3.14 | 1626 |
| 2/2/09 | 1.8 | 1262 | 3.14 | 1629 |
| 2/3/09 | 1.96 | 1264 | 3.29 | 1632 |
| 2/4/09 | 1.96 | 1266 | 3.29 | 1636 |
| 2/5/09 | 1.96 | 1268 | 3.29 | 1639 |
| 2/6/09 | 1.96 | 1270 | 2.82 | 1642 |
| 2/7/09 | 1.96 | 1272 | 3.14 | 1645 |
| 2/8/09 | 1.64 | 1274 | 3.14 | 1648 |
| 2/9/09 | 1.48 | 1275 | 2.98 | 1651 |
| 2/10/09 | 1.64 | 1277 | 2.98 | 1654 |
| 2/11/09 | 1.48 | 1278 | 2.98 | 1657 |
| 2/12/09 | 1.64 | 1280 | 2.67 | 1660 |
| 2/13/09 | 0.85 | 1281 | 2.67 | 1662 |
| 2/14/09 | 0.21 | 1281 | 2.67 | 1665 |
| 2/15/09 | 0.21 | 1281 | 2.67 | 1668 |
| 2/16/09 | 0.21 | 1281 | 2.35 | 1670 |
| 2/17/09 | 0.21 | 1281 | 2.67 | 1673 |
| 2/18/09 | 0.21 | 1282 | 2.67 | 1675 |
| 2/19/09 | 0.21 | 1282 | 2.82 | 1678 |
| 2/20/09 | 0.21 | 1282 | 3.14 | 1681 |
| 2/21/09 | 0.37 | 1282 | 0.67 | 1682 |
| 2/22/09 | 0.53 | 1283 | 2.98 | 1685 |
| 2/23/09 | 0.85 | 1284 | 2.35 | 1687 |
| 2/24/09 | 0.53 | 1284 | 1.56 | 1689 |
| 2/25/09 | 0.21 | 1285 | 2.03 | 1691 |
| 2/26/09 | 0.21 | 1285 | 2.51 | 1693 |
| 2/27/09 | 0.21 | 1285 | 2.67 | 1696 |
| 2/28/09 | 0.37 | 1285 | 2.82 | 1699 |
| 3/1/09 | 0.21 | 1286 | 2.82 | 1702 |
| 3/2/09 | 0.53 | 1286 | 2.98 | 1705 |
| 3/3/09 | 1.17 | 1287 | 2.82 | 1708 |
| 3/4/09 | 1.48 | 1289 | 2.67 | 1710 |
| 3/5/09 | 1.17 | 1290 | 2.67 | 1713 |
| 3/6/09 | 1.33 | 1291 | 2.67 | 1716 |
| 3/7/09 | 0.69 | 1292 | 2.35 | 1718 |
| 3/8/09 | 0.85 | 1293 | 1.56 | 1720 |
| 3/9/09 | 0.21 | 1293 | 1.56 | 1721 |
| 3/10/09 | 0.21 | 1293 | 2.35 | 1723 |
| 3/11/09 | 0.21 | 1293 | 2.19 | 1726 |
| 3/12/09 | 0.21 | 1294 | 2.35 | 1728 |
| 3/13/09 | 0.69 | 1294 | 2.35 | 1730 |
| 3/14/09 | 0.85 | 1295 | 2.51 | 1733 |

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| 3/15/09 | 1.33 | 1297 | 2.03 | 1735 |
| 3/16/09 | 0.85 | 1297 | 1.72 | 1737 |
| 3/17/09 | 1.01 | 1298 | 2.36 | 1739 |
| 3/18/09 | 1.01 | 1299 | 2.35 | 1741 |
| 3/19/09 | 1.64 | 1301 | 2.51 | 1744 |
| 3/20/09 | 1.33 | 1302 | 2.67 | 1746 |
| 3/21/09 | 1.33 | 1304 | 2.98 | 1749 |
| 3/22/09 | 1.8 | 1305 | 2.82 | 1752 |
| 3/23/09 | 1.8 | 1307 | 2.67 | 1755 |
| 3/24/09 | 1.48 | 1309 | 2.82 | 1758 |
| 3/25/09 | 1.48 | 1310 | 2.98 | 1761 |
| 3/26/09 | 1.96 | 1312 | 2.98 | 1764 |
| 3/27/09 | 1.8 | 1314 | 2.98 | 1767 |
| 3/28/09 | 1.8 | 1316 | 2.98 | 1770 |
| 3/29/09 | 1.8 | 1318 | 2.51 | 1772 |
| 3/30/09 | 1.64 | 1319 | 2.98 | 1775 |
| 3/31/09 | 1.96 | 1321 | 3.14 | 1778 |
| 4/1/09 | 1.96 | 1323 | 3.14 | 1781 |
| 4/2/09 | 1.96 | 1325 | 3.14 | 1785 |
| 4/3/09 | 2.59 | 1328 | 3.77 | 1788 |
| 4/4/09 | 2.9 | 1331 | 3.61 | 1792 |
| 4/5/09 | 2.27 | 1333 | 3.45 | 1795 |
| 4/6/09 | 2.27 | 1335 | 3.61 | 1799 |
| 4/7/09 | 2.74 | 1338 | 3.77 | 1803 |
| 4/8/09 | 2.74 | 1341 | 3.92 | 1807 |
| 4/9/09 | 3.06 | 1344 | 3.77 | 1810 |
| 4/10/09 | 2.9 | 1347 | 4.08 | 1815 |
| 4/11/09 | 3.22 | 1350 | 3.92 | 1818 |
| 4/12/09 | 3.06 | 1353 | 3.29 | 1822 |
| 4/13/09 | 2.9 | 1356 | 3.92 | 1826 |
| 4/14/09 | 3.37 | 1359 | 4.08 | 1830 |
| 4/15/09 | 3.84 | 1363 | 4.08 | 1834 |
| 4/16/09 | 3.37 | 1366 | 3.61 | 1837 |
| 4/17/09 | 2.9 | 1369 | 3.92 | 1841 |
| 4/18/09 | 3.37 | 1373 | 4.08 | 1845 |
| 4/19/09 | 3.37 | 1376 | 3.77 | 1849 |
| 4/20/09 | 3.84 | 1380 | 3.61 | 1853 |
| 4/21/09 | 3.99 | 1384 | 3.92 | 1857 |
| 4/22/09 | 3.84 | 1388 | 3.92 | 1861 |
| 4/23/09 | 4.31 | 1392 | 3.77 | 1864 |
| 4/24/09 | 4.31 | 1396 | 4.08 | 1869 |
| 4/25/09 | 4.92 | 1401 | 4.23 | 1873 |
| 4/26/09 | 5.39 | 1407 | 4.39 | 1877 |
| 4/27/09 | 5.86 | 1412 | 4.39 | 1882 |
| 4/28/09 | 6.17 | 1419 | 4.55 | 1886 |
| 4/29/09 | 6.48 | 1425 | 4.71 | 1891 |
| 4/30/09 | 7.09 | 1432 | 4.86 | 1896 |
| 5/1/09 | 7.71 | 1440 | 4.71 | 1900 |
| 5/2/09 | 8.33 | 1448 | 4.55 | 1905 |
| 5/3/09 | 7.56 | 1456 | 4.55 | 1909 |

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| 5/4/09 | 6.79 | 1463 | 4.55 | 1914 |
| 5/5/09 | 7.09 | 1470 | 4.71 | 1919 |
| 5/6/09 | 8.94 | 1479 | 4.86 | 1924 |
| 5/7/09 | 9.24 | 1488 | 4.71 | 1928 |
| 5/8/09 | 9.24 | 1497 | 4.71 | 1933 |
| 5/9/09 | 9.86 | 1507 | 4.71 | 1938 |
| 5/10/09 | 9.24 | 1516 | 4.55 | 1942 |
| 5/11/09 | 8.63 | 1525 | 6.71 | 1949 |
| 5/12/09 | 8.02 | 1533 | 6.73 | 1956 |
| 5/13/09 | 8.63 | 1541 | 7.19 | 1963 |
| 5/14/09 | 9.24 | 1551 | 5.64 | 1969 |
| 5/15/09 | 8.17 | 1559 | 6.73 | 1975 |
| 5/16/09 | 7.71 | 1567 | 7.19 | 1982 |
| 5/17/09 | 8.78 | 1575 | 6.79 | 1989 |
| 5/18/09 | 10.33 | 1586 | 6.11 | 1995 |
| 5/19/09 | 11.25 | 1597 | 7.04 | 2002 |
| 5/20/09 | 9.56 | 1607 | 6.73 | 2009 |
| 5/21/09 | 10.17 | 1617 | 6.11 | 2015 |
| 5/22/09 | 9.86 | 1627 | 6.88 | 2022 |
| 5/23/09 | 10.33 | 1637 | 10.13 | 2032 |
| 5/24/09 | 10.02 | 1647 | 9.82 | 2042 |
| 5/25/09 | 9.56 | 1656 | 8.43 | 2051 |
| 5/26/09 | 9.86 | 1666 | 10.29 | 2061 |
| 5/27/09 | 7.71 | 1674 | 9.19 | 2070 |
| 5/28/09 | 7.56 | 1682 | 7.97 | 2078 |
| 5/29/09 | 7.56 | 1689 | 7.19 | 2085 |
| 5/30/09 | 7.56 | 1697 | 7.97 | 2093 |
| 5/31/09 | 7.87 | 1705 | 10.60 | 2104 |
| 6/1/09 | 8.63 | 1713 | 10.44 | 2114 |
| 6/2/09 | 10.94 | 1724 | 10.13 | 2124 |
| 6/3/09 | 11.56 | 1736 | 9.51 | 2134 |
| 6/4/09 | 11.87 | 1748 | 9.19 | 2143 |
| 6/5/09 | 11.56 | 1759 | 13.85 | 2157 |
| 6/6/09 | 12.02 | 1771 | 9.35 | 2166 |
| 6/7/09 | 11.25 | 1782 | 9.98 | 2176 |
| 6/8/09 | 10.94 | 1793 | 11.22 | 2187 |
| 6/9/09 | 11.72 | 1805 | 12.77 | 2200 |
| 6/10/09 | 11.72 | 1817 | 12.77 | 2213 |
| 6/11/09 | 11.25 | 1828 | 12.77 | 2226 |
| 6/12/09 | 10.79 | 1839 | 12.62 | 2238 |
| 6/13/09 | 10.94 | 1850 | 14.01 | 2252 |
| 6/14/09 | 11.41 | 1861 | 14.47 | 2267 |
| 6/15/09 | 11.1 | 1872 | 14.16 | 2281 |
| 6/16/09 | 11.25 | 1884 | 14.01 | 2295 |
| 6/17/09 | 11.1 | 1895 | 14.47 | 2309 |
| 6/18/09 | 11.1 | 1906 | 12.62 | 2322 |
| 6/19/09 | 10.63 | 1916 | 13.24 | 2335 |
| 6/20/09 | 10.33 | 1927 | 13.39 | 2349 |
| 6/21/09 | 10.17 | 1937 | 13.24 | 2362 |
| 6/22/09 | 10.33 | 1947 | 13.85 | 2376 |

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| 6/23/09 | 10.33 | 1958 | 12.62 | 2388 |
| 6/24/09 | 10.33 | 1968 | 12.14 | 2401 |
| 6/25/09 | 10.02 | 1978 | 13.08 | 2414 |
| 6/26/09 | 10.02 | 1988 | 12.30 | 2426 |
| 6/27/09 | 9.56 | 1997 | 12.14 | 2438 |
| 6/28/09 | 9.86 | 2007 | 11.52 | 2450 |
| 6/29/09 | 9.56 | 2017 | 10.91 | 2460 |
| 6/30/09 | 9.4 | 2026 | 11.52 | 2472 |
| 7/1/09 | 9.56 | 2036 | 11.83 | 2484 |
| 7/2/09 | 11.1 | 2047 | 12.77 | 2497 |
| 7/3/09 | 11.41 | 2058 | 12.30 | 2509 |
| 7/4/09 | 11.1 | 2069 | 13.39 | 2522 |
| 7/5/09 | 11.72 | 2081 | 12.77 | 2535 |
| 7/6/09 | 11.72 | 2093 | 13.54 | 2549 |
| 7/7/09 | 11.41 | 2104 | 14.32 | 2563 |
| 7/8/09 | 12.18 | 2116 | 15.26 | 2578 |
| 7/9/09 | 12.33 | 2129 | 14.47 | 2593 |
| 7/10/09 | 11.72 | 2141 | 14.94 | 2608 |
| 7/11/09 | 12.33 | 2153 | 15.26 | 2623 |
| 7/12/09 | 12.49 | 2165 | 15.11 | 2638 |
| 7/13/09 | 11.87 | 2177 | 15.26 | 2653 |
| 7/14/09 | 11.87 | 2189 | 15.42 | 2669 |
| 7/15/09 | 12.18 | 2201 | 16.21 | 2685 |
| 7/16/09 | 12.33 | 2214 | 16.37 | 2701 |
| 7/17/09 | 12.96 | 2227 | 16.53 | 2718 |
| 7/18/09 | 12.64 | 2239 | 16.53 | 2734 |
| 7/19/09 | 12.96 | 2252 | 16.21 | 2750 |
| 7/20/09 | 12.96 | 2265 | 16.06 | 2767 |
| 7/21/09 | 12.49 | 2278 | 16.53 | 2783 |
| 7/22/09 | 12.18 | 2290 | 17.17 | 2800 |
| 7/23/09 | 12.8 | 2303 | 17.01 | 2817 |
| 7/24/09 | 13.11 | 2316 | 16.85 | 2834 |
| 7/25/09 | 14.03 | 2330 | 17.65 | 2852 |
| 7/26/09 | 14.19 | 2344 | 18.62 | 2870 |
| 7/27/09 | 14.81 | 2359 | 19.11 | 2889 |
| 7/28/09 | 15.28 | 2374 | 19.11 | 2909 |
| 7/29/09 | 14.81 | 2389 | 19.59 | 2928 |
| 7/30/09 | 14.81 | 2404 | 19.11 | 2947 |
| 7/31/09 | 14.97 | 2419 | 18.78 | 2966 |
| 8/1/09 | 14.34 | 2433 | 18.78 | 2985 |
| 8/2/09 | 13.88 | 2447 | 18.94 | 3004 |
| 8/3/09 | 13.42 | 2460 | 18.94 | 3023 |
| 8/4/09 | 14.03 | 2474 | 19.92 | 3043 |
| 8/5/09 | 14.19 | 2488 | 19.43 | 3062 |
| 8/6/09 | 13.88 | 2502 | 18.46 | 3081 |
| 8/7/09 | 13.57 | 2516 | 18.46 | 3099 |
| 8/8/09 | 13.88 | 2530 | 17.81 | 3117 |
| 8/9/09 | 12.96 | 2543 | 17.65 | 3134 |
| 8/10/09 | 12.8 | 2556 | 16.69 | 3151 |