CENWP-OD 18 September 2013

MEMORANDUM FOR THE RECORD

Subject: FINAL minutes for the 18 September 2013 FPOM Pinniped Task Group meeting.

The meeting was in the Columbia Room (12th floor) at the new CRITFC building. In attendance:

Last	First	Agency	Office/Mobile	Email
Brown	Robin	ODFW	541-760-9545	Robin.f.brown@state.or.us
Fredricks	Gary	NOAA	503-231-6855	Gary.fredricks@noaa.gov
Gibbons	Karrie	NWP-FFU		Karrie.m.gibbons@usace.army.mil
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Hausmann	Ben	NWP-BON	541-374-4598	Ben.j.hausmann@usace.army.mil
Jeffries	Steven	WDFW		Steven.jeffries@dfw.wa.gov
Mackey	Tammy	USACE-NWP	503-961-5733	Tammy.m.mackey@usace.army.mil
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Norberg	Brent	NOAA		Brent.norberg@noaa.gov
Stansell	Robert	NWP-FFU		Robert.j.stansell@usace.army.mil
Traylor	Andy	NWP		Andrew.w.traylor@usace.army.mil
VanderLeeuw	Bjorn	NWP-FFU		Bjorn.van-der-leeuw@usace.army.mil
Wright	Bryan	ODFW	541-757-5225	Bryan.e.wright@state.or.us
Griffin	Garth	NOAA		Garth.griffin@noaa.gov
Murray	Schlenker	WDFW Enforcement		Murray.schlenker@dfw.wa.gov
Dave	Roberts	BPA		Daroberts@bpa.gov

Objective: The objective of this meeting is to have the agencies that are engaged in the pinniped issue share and discuss information on planned work for the upcoming years (2014-2018). Additional topics surrounding this issue will also be discussed if time permits.

Brief introductions of all participants

1. **Recommendations from the meeting.**
   - **1.1.** Recommendation to USACE was to maintain a level of monitoring that allows for individual identification as well as maintaining confidence in the predation data collected.
   - **1.2.** Recommendations were to consider reducing spring observers and spreading them out to include the month of December when Stellers are predating upon winter steelhead.
   - **1.3.** The group recommended going forward with using ruggedized RC boats to see how sea lions react.
   - **1.4.** The States and CRITFC will elevate the request for access to the dock and for addressing concerns with protestors at the dam if BON is unresponsive to requests by Hausmann and Stansell.

2. **Bonneville Dam Security.**
   - **2.1.** Is the current security configuration adequate? WDFW law enforcement is getting pressure to reduce time and effort spent at BON. Oregon hasn't gotten any pressure but wonders if they are needed at BON. Both enforcement officers reported there haven't been many issues. ODFW said the security has been great and there are no complaints, even when the Sea Shepherd folks were using the same campground where the States have their camp trailers. Brown would like to see stronger consequences when potential

protestors violate restricted access areas. Jeffries recommended additional signage. He also said the original security plan had a designated location for organized protestors; maybe that needs to be enforced.

2.2. Bonneville has contracted security guards. One guard at OR gate, one at WA gate and one in a roving vehicle. They are armed, but are not law enforcement officers.

2.3. Bonneville has Park Rangers. They are natural resource rangers, not law enforcement rangers, hence no weapons or power to arrest. Rangers are not willing to engage in restricting visitors, even when the restricted access areas are ignored. The States will likely elevate this issue to upper levels in NWP. Hausmann said the signage is likely doable. Van der Leeuw noted the Rangers generally take the stance of keeping a low profile so the protestors do not have any fodder to further their message. Hatch expressed concerns with the Tribal hazers using the Hamilton Island boat ramp due to harassment by protesters. He would like to have them moor the boats at the Project dock instead. Docking the boats there won't be allowed until the boat house can be removed (it isn't suitable for the location) or upgraded. Van der Leeuw said he was told the dock is primarily for temporary transiting navlock users not for long term mooring, but BON is open to requests for moorage, much like the States have done in recent years. The States and CRITFC will likely elevate this request as well.

2.4. OR & WA have called their law enforcement when necessary.

3. Observation Program – January through May (USACE)

3.1. Brief update from FFU on 2013 data. Stansell and Van der Leeuw gave an update on what has been seen in 2013. The final report is currently going through internal review.

3.2. The Corps plans to reduce observation effort due to funding constraints. Stansell said a reduction in monitoring would likely result in a decrease of individual identification data but not predation estimates. Stansell asked if the States are considering taking over monitoring. Brown said the ODFW view is that the dam is owned by USACE so monitoring is a USACE responsibility. Fredricks said monitoring is a requirement of the BiOp so NOAA won't be able to take on the monitoring activities. CRITFC agreed that USACE carries the responsibility for monitoring. Jeffries asked what cutting back would look like. Stansell said it would be a reduction to 6-8 hours a day instead of all day. Fredricks asked if the hours would be blocked. Stansell said those details are still being worked out. He said a completely randomized schedule isn't likely to be doable but a block schedule should be. Instead of six observers there would be three observers. This reduces the number of houses needed for lodging as well. Fredricks said NOAA will be responsible for determining if the precision is acceptable and meets BiOp requirements. ODFW said the cuts would likely increase the time it takes to get an individual on the removal list. Van der Leeuw noted that there seems to be a lot of effort by the Corps in observing and identification of individual sea lions but not a lot of removal occurring. ODFW suggested the animals do not readily use the traps so while there are individuals slated for removal, getting them in the trap has been difficult. Brown said ODFW may seek lethal removal of Stellers, if they get de-listed, if they follow the same predation trend as the California sea lions. **Recommendation to USACE was to maintain a level of monitoring that allows for individual identification as well as maintaining confidence in the predation data collected.**

3.2.1. The group discussed the need to exert the same level of observations of Stellers as was used for Californias. FFU did not intend to reduce the staff level of participation, just the SCA interns.

3.3. The FFU is working with Bryan Wright (ODFW) to develop a new sampling design.

4. Fall Observation Pilot Program – October through December (USACE)

4.1. Stellers have been arriving at BON in September. They are primarily consuming salmonids and sturgeon in the tailrace. The concern over predation of winter steelhead was discussed. This may result in hiring the observers earlier in the season. This may lead to a nine month season rather than the three or five month season we had in the beginning. A nine month observation season would cover all the months that Stellers are now commonly observed in the BON tailrace. **Recommendations were to consider reducing spring observers and spreading them out throughout the year, at least to include December.** More discussion will be needed to determine the Fall/Winter timing.

4.2. The Corps conducted a pilot program to observe this predation during Oct-Dec in 2011 & 2012. Vanderleeuw described the level of Steller abundance and predation that is usually seen in the Oct-Dec timeframe.

4.3. Currently the FFU does not have the personnel needed to perform a full observation program in the fall/early winter.

4.4. Is this program needed to monitor the impact of Stellers on sturgeon and salmonids? If needed, who will provide funding and/or staff?

5. Removal Program (ODFW & WDFW)

5.1. Brief update from the states. There were four removals from the basin this past spring, two lethal removals and two relocated to a zoo. ODFW will continue to trap and remove animals in Astoria.

5.2. What is the general plan for 2014? More or less trapping? A new trap was built and placed around The Dalles Marina. Another trap was put up around Stevenson. Hatch reported that they get many reports that sea lions are taking fish out of the tribal nets that are placed in the area from the cemetery to the boat dock. The group talked about putting a trap at the tip of Cascades Island or at the rocks just upstream of BON. The States are willing to put a trap there, and risk losing it, but will BON be willing to risk having a trap to float into the dam? The concern would be getting a trap in the opening of the B2CC, but if it's placed after spill season, that shouldn't be a problem.

5.3. Will the States pursue a removal program after this permit expires? That would depend on the levels of predation that continue at the end of the current removal authority perod.

6. Branding and Tagging (ODFW & WDFW)

6.1. Brief update from the states. Even if Steller sea lions are de-listed, the States will still have to anesthetize prior to branding, due to public pressure, even though general anesthesia presents a greater risk to the animals.

6.2. What is the general plan for 2014?

6.3. Will there be any Steller branding in 2014? Some of the animals are too big to handle safely. Any animal that fits in the squeeze cage can be branded. Although there is still time to talk and change, currently the plan is not to trap and brand Stellers early in the year, but rather focus on California sea lions during the spring (due to limited funding).

6.4. The use of oil-based paintballs would allow for identification within a season. Effective use of paintballs for marking would require some planning before deployment. This is still a desirable option, if BON would allow it. Stansell said choosing a color and a side

each day would help the observers better identify individuals. Paintballs would be effective for one season before the paint washes or rubs off and the sea lions molt.

6.5. Are there any other marking methods that can be used? No new methods currently being discussed. Wright said that the States do not plan to equip sea lions with telemetry gear this year. Van der Leeuw noted that we still don't know if Stellers can swallow a steelhead underwater. They often see a Steller pop up with a tail going down its throat. Wright will make contact with NatGeo to see if they may come back to BON in order to attach CritterCams to sea lions.

7. Hazing (USDA & CRITFC)

7.1. Dam-based hazing will be the same as years past. March-May, 7 days/wk, 8 hrs/day. USDA will be doing the hazing.

7.2. Brief update from CRITFC on boat-based hazing. Similar effort as in previous years. Plan on 3-4 days a week. Will also do river counts down to Astoria. Also want to put a crew up in the forebay to get observations of sea lions predation activity upstream of the dam. Hatch said he would like to avoid hazing up there and just do observations. The group agreed observations would be best so we could get a better idea of what the animals are doing in the forebay. Brown suggested reducing boat hazing to one to two days a week. He suggested three to four days a week may not do much good. Hatch said some of the CRITFC Commissioners feel the hazing is effective and would like to see hazing increased to eight days a week. Brown voiced some concern about how the hazing in implemented. Fredricks brought up his concerns about hazing too close to the fishways and firing cracker shells into the water. Hausmann confirmed there are proximity issues with the closeness of the boats to the fishway. Van der Leeuw said sometimes the boat hazers are called in to chase pinnipeds out of the corners. Hausmann recommended using dam-based hazers as far downstream as possible and then letting the boat hazers pick up from there. Fredricks agreed. Jefferies said if the hazers chase pinnipeds too far downstream, then they lose the ability to associate the hazing with a behavior we want to modify, i.e. predating near the dam. More effective hazing would be to haze when they are actively hunting, not continue to chase them downstream. Stansell agreed the hazing is more effective on new animals rather than those that come back repeatedly. Hatch explained the CRITFC protocols of chasing down to Tanner Creek and only firing 5 shots. Jefferies went back to the advice from trainers who said hazing a sea lion eating a fish isn't as effective as hazing a sea lion actively pursuing a fish. The goal should be negative reinforcement for hunting fish near the dam. A hazing event should be halted once a sea lion has stopped the undesirable behavior.

7.3. Should hazing be expanded to cover Sept-Dec and Jan-Feb?

7.4. Should daily hazing schedules be altered to provide better coverage? USDA generally covers early morning until early afternoon (miss late afternoon predation). CRITFC generally covers the middle of day when there is less predation. We have two groups hazing the middle of the day. Weekends are only covered by one USDA hazer. Brown said this item assumes hazing has an effect and generally people believe hazing isn't effective. Van der Leeuw noted CRITFC tends to be there during the lull in pinniped activity. Jefferies stressed the hazing should occur during the times of feeding activity. Stansell said while he does believe that hazing is ineffective, the data shows there was some limited, short term effect on predation timing due to the dam and boat based hazing.

7.4.1. Hazing is hopefully effective on naïve animals.
7.4.2. Hazing near the fishways hopefully reduces predation.
7.4.3. Hazing is required, as a removal criteria, under the permit.

7.5. Any new hazing methods? Jeffries brought up the acoustic devices used. He said the ADDs may not have been effective due to background noise. There may be some testing to determine why ADDs did not work at BON when they have worked elsewhere. Fredricks said there was a good mapping of acoustic tags and noise at ICH. He didn't have a report but suggested Van der Leeuw contact NWW/PNNL for more information. Jefferies asked what the chances of USACE doing acoustic fingerprinting. Stansell said there isn't the funding and what would you do about changing background noise and entrained air when you determined that was the cause. Norberg asked about the cost associated with the LRAD device, which was looked at for JDA avian hazing. Fredricks said infrasound has been used successfully for birds but he wasn't sure if it has been tested underwater.

7.6. Possible upcoming tests of ruggedized RC boats for hazing. If the Corps can line up these tests, when should they be conducted? January, when Stellers are present or wait until both pinniped species are present in April. Van der Leeuw said these are ruggedized boats and have been purchased by NOAA for use in hurricane research. The RC boat company (Hydronalix, Inc.) is willing to come up and test the boat at BON to see if they are effective at moving sea lions. Norberg suggested testing it with just Stellers in the river to see if the change in tactics would scare them out. Brown expressed some reservations, but he recommended testing when there is just one species of pinniped, low fish numbers and no media. Jeffries suggested using the boats to break up rafted animals. Norberg suggested adding a modification so a noise could be emitted through the hull of the RC boat. **The group recommended going forward with using RC boats to see how sea lions react.**

8. Future Plans

8.1. Discussion on where this issue is headed in the next 5 years. Likely to require continued monitoring and some level of hazing.

8.2. Is there an 'end-point'? Reducing predation to some level? If pinniped numbers were reduced to less than a dozen individuals, that might be seen as a number not worth worrying about. It was suggested that even if we decreased numbers of pinnipeds, monitoring and hazing may end; it may become a maintenance program to ensure numbers do not increase again. But this will likely not happen in the near future, and even if California sea lions are no longer the problem, the region will likely still be concerned about Steller sea lions taking the same path as the California sea lions by increasing presence and predation on salmon.

9. Bonneville Project Support

9.1. Is there a need for crane support in 2014? Maybe up to three times during the season but if 2014 goes similar to 2013, there is little need for a crane. Will need navlock support for moving traps around. Stansell says in the past NWP puts $15K in a labor code for BON each year. Money not used can be put towards other NWP Fisheries needs.

9.2. Bonneville built a new platform in the old navigation lock that should aid in viewing the traps.

9.3. The traps will remain closed until mid-March or April (probably meant mid-March). Stansell said there are pinnipeds hauling out on the squeeze cage. The States discussed moving it so Stellers wouldn't haul out and possibly damage the squeeze cage.

10. Communication and Information Sharing

10.1. Is more communication needed? A simple email ring among the project leads may be sufficient. The email appears to be sufficient. This keeps BON apprised of Astoria actions as well.

10.2. Is there a better way to disseminate information among the groups? This can be broken out into short-term (e.g. do not go near the traps) and long-term (e.g. sharing data on brand re-sights). If NWP sees animals on the traps, they should notify the States.

11. Upriver Sea Lions

11.1. Brief update from CRITFC. Hatch said he has gotten reports of sea lions near the marina. He has photos as well. B animal (IO), C014, U95, small unbranded animal have been seen upstream of BON. IO is a 1300-1400lbs and unbranded.

11.2. Brief update from the States.

11.3. Any plan of action beyond what is being done now? There is an electric fence idea being used at other locations. As animals approach a dock to haul out, their nose touches the hot wire and tend not to haul out on the dock. Jeffries asked Norberg about the Smith-Root electrified dock. That system may be installed in California. Jeffries said we just need a perimeter wire for the dock. This may be a suitable solution for the dock at TDA. Brown suggested there needs to be some care and consideration before installing since the dock is a private dock and recreational boaters may also use it. We don't want to zap the public.

12. Update on Legal Issues

12.1. Arguments to be delivered to the 9th Circuit Court on 20 September 2013. All of the three judges are from the original appeal. This is believed to be a benefit for the States and NOAA. (Update: on September 27 the 9th Circuit Court ruled in favor of NMFS and the States, and as such the current lethal removal authority will be in place for the 2014 season).

12.2. H.R. 1308: Endangered Salmon and Fisheries Predation Prevention Act. This bill was assigned to a congressional committee on March 21, 2013, which will consider it before possibly sending it on to the House or Senate as a whole. Not much chance of it being enacted into law.

13. Proposal to Delist the Eastern DPS of the Steller Sea Lion (NOAA)

13.1. Brief update from NOAA; announcement of delisting is imminent. NOAA has a long list of actions people can do to protect property, pets, etc. Once the announcement is made, the webpage will be updated to include this info.

14. Public Relations

14.1. Any new course of action? No new actions. It's an ongoing management program.

14.2. Same POCs?

Simulation of Six-Hour Sampling Schemes for Estimating Sea Lion Predation on Spring Chinook Salmon in the Bonneville Dam Tailrace

In recent years, observation of sea lion predation on fish at Bonneville Dam has covered most hours from dawn to dusk every day during the spring Chinook salmon run excepting weekends. Occasional observations have determined that there is much less predation occurring during the nighttime hours, but this nighttime predation has only been roughly quantified. The observations were performed by a crew of six. Their schedule during the spring Chinook run allowed them to cover the three tailrace locations (the first and second powerhouses and spillway) during the sixteen hours from 0400 through 1900 except for either the first or the last hour and one hour at midday on any given day. Predation counts were extrapolated or interpolated to account for these missed daylight hours. One of the prey species the observers were required to quantify was Chinook salmon. The predation counts were adjusted to estimate total predation on Chinook in the Bonneville tailrace. There is an error associated with this estimate due to various causes. The following is an attempt to estimate by simulation the additional error that would be incurred by observing for fewer hours than the full sixteen daylight hours. Various six-of-sixteen sampling schemes were tested. A real six-hour sampling schedule in future years could be performed by a crew of three. The method used in this exercise was to take six-hour samples from the sixteen-hour data sets for the four years 2010 - 2013. The six-hour predation counts were expanded to sixteen hours and the result compared to the observed actual sixteen-hour counts.

Each of the years 2010 through 2013 provided a nearly complete set of hourly predation counts (with the small amount of interpolation and extrapolation mentioned above) for the bulk of the spring Chinook run for the hours 0400 through 1900. The bulk of the run occurred from early April to mid May for these four years. The predation count is the total number of spring Chinook taken by both California and Stellar sea lions at all three tailrace locations. The four years were studied separately. As a specific example, consider 2010. On each day of the run for 2010, six hours were selected. The six-hour predation count was expanded to the full sixteen hours based on an estimate of the distribution (or profile) of counts across the sixteen hours . The observed counts and the expanded estimates were then added across days. The observed total was subtracted from the estimated total and the result divided by the observed total to give an estimate of the relative error due to sampling. This estimated error depends critically on how well the estimated hourly distribution used in the expansions matches the actual distribution for each day used in the analysis for 2010. The estimated distribution actually used for 2010 was the average of the distributions for 2011, 2012, and 2013. For 2011, the distribution used was the average of the distributions for 2010, 2012, and 2013. And likewise, for 2012 and 2013, the distribution used was the average of the distributions for the three out years. The justification for this choice of distributions was the good match (stability) in the distributions across the four years. This is shown in Figures 1 - 6. Figure 1 shows a superposition of the hourly distributions of the predation counts averaged over days and normalized as percent of the sixteen-hour total for the four years. Figure 2 shows the average

of these distributions over the four years. Figure 3 shows a comparison of the profile for 2010 to the average profile for the three out-years, 2011, 2012, and 2013. In this figure, the mismatch between the two profiles for a particular hour that is sampled in the simulation is an indicator of the contribution to the error to be expected due to that hour when expanding the count. (Actually, it is not the mismatch between the average profile for the three out years and the average profile across days for the study year that determines the error - it is the mismatch between three-year average and the profile for each individual day that determines the error.) Figures 4, 5, and 6 show the analogous comparisons for the years 2011, 2012, and 2013 respectively.

The simulations were performed on Excel spreadsheets, one for each of the four years. One column of the spreadsheet for a particular year contains the predation counts for each hour from 0400 to 1900 for each day of the simulation (the bulk of the spring Chinook run, weekends excluded). (Each day contains one interpolated count and one extrapolated count.) Another column contains the average hourly profile for the three out-years. The same profile is repeated down the column for each day. A third column contains the particular sampling scheme being simulated. A sampled hour is indicated with a one, a non-sampled hour is indicated with a zero. Based on these columns, an estimated total predation for each day is calculated by expanding the six-hour count. Taking 2010, again, as a specific example, the simulation is asking: What if, in 2010 we had sampled each day for these six hours and expanded the predation counts based on this estimated hourly profile? What would our estimate of the sixteen-hour daily predation count be? (The fact that, in this simulation, the estimated profile used for 2010 happens to be based on three future years is irrelevant since there is no obvious trend in the profiles across the four years.) The daily estimates are added and compared with the observed total in order to estimate the relative error due to sampling.

Four different six-hour sampling schemes were studied for each of the four years - an early schedule, a late schedule, and two alternating schedules. The early schedule sampled the hours 5, 6, 7, 10, 11, and 12. The late schedule sampled the hours 10, 11, 12, 14, 15, and 16. The alternating schedules used the early and the late schedules on alternate weeks. Schedule Alt1 started with the early schedule for the first week, schedule Alt2 started with the late schedule for the first week. The strategy for picking the particular hours to sample was based on the hourly profile shown in Figure 2. The idea was to choose hours when predation was likely to be highest. The predation counts for these hours would be based on actual observation rather than derived by expansion and, therefore, would not contribute to the error. Since these are likely to be the highest counts, the total error due to sampling should be less. The reason why the early, late, and alternating schedules were chosen is due to the bimodal shape of the profile shown in Figure 2 and the reality of a crew of three working eight-hour shifts. The relative errors due to sampling are tabulated below. The purpose of the table is not so much to demonstrate the superiority of a particular sampling scheme but rather to show the range of errors that might be expected from six-hour sampling. The simulated errors range from -8 to +10 percent. The fact that, overall, the early schedule performed better than the late schedule

for these four years does not mean it would necessarily do so in a future real-world predation study. The differences are largely due to how well the estimated hourly profiles happened to match the real hourly distributions of predation counts day-to-day in the simulations. This is evident by comparing the errors for the Alt1 and Alt2 schedules. The only difference between the schedules is whether you choose to start the first week with the early or the late schedule. Figure 7 shows the relationship between the sampling error and profile mismatch for the early and late schedules for the four years. Profile mismatch is the sum of the mismatch for the sampled hours for the pairs of profile shown in Figures 3 - 6.

Table 1

Sampling Scheme	Percent Error
2010-Early	-3%
2011-Early	2%
2012-Early	2%
2013-Early	0%
2010-Late	-8%
2011-Late	2%
2012-Late	-1%
2013-Late	10%
2010-Alt1	-6%
2011-Alt1	4%
2012-Alt1	-1%
2013-Alt1	6%
2010-Alt2	-6%
2011-Alt2	0%
2012-Alt2	2%
2013-Alt2	3%

An alternating schedule should be more robust than either an early or late schedule by itself. This is because it uses more of the estimated hourly distribution in estimating the expanded predation counts and is thereby less prone to error caused by mismatch for particular hours. One of the alternating schedules, or something similar, would seem to be the best choice for sampling. Because of the overlap in sampled hours (if for no other reason), the error estimates for the Alt1 and Alt2 schedules for the same year are not independent. Simulation based on only four years for any particular sampling schedule does not provide enough error estimates to determine how likely the error would exceed a particular value in a real-world future application

of that schedule. In order to get some indication of what the probability of attaining a particular level of accuracy for six-hour sampling, for example, less than 5% error or less than 10% error, a different approach was adopted as described below.

In order to estimate the distribution of errors to be expected from six-hour samples from the sixteen-hour counts, two new spreadsheets were created for each of the four years. These spreadsheets were the same as the spreadsheets described above except that now the particular six hours sampled were chosen randomly. For each spreadsheet, the distribution of errors was estimated with a Monte Carlo simulation using 10000 iterations. In one of the spreadsheets for a particular year, a random selection of six hours between 4 and 19 was selected (no duplicates), and these six hours were the selected sampling schedule for every day for that iteration (semi-random). In the other spreadsheet for that year, a different random selection of six hours was applied to each day in each iteration (random). The results for 2013 are shown in Figures 8 and 9. The circles in the figures represent the histogram of the errors from the simulation, and the solid line is a normal distribution curve based on the mean and the standard deviation of the errors from the simulation. The horizontal axis gives the error expressed as a fraction, not as percent. The point 0.1 represents a positive error (estimate exceeds actual count) of ten percent. The vertical axis represents the relative bin count expressed as a fraction. Both figures are scaled the same. Applying the same six hours to every day in an iteration is closer to a feasible sampling scheme than the fully random scheme. Applying a different six hours to every day in an iteration produced a more favorable distribution of errors. This was true for all four years. The more favorable distribution is likely due to the fact that a six-hour selection that happens to be a bad match is not applied to all the days in the iteration in the fully random scheme resulting in fewer of the larger errors. This scheme, although completely unfeasible, is probably close to ideal in terms of minimizing to chance of incurring large errors. For each of the eight simulations, the estimated probability of exceeding an absolute error of five and ten percent was calculated in two different ways. The direct way was to simply count the number of errors exceeding the target error. The indirect way was to calculate a Z-score based on the mean and standard deviation and assume that the distributions of errors were sufficiently normal. The results are tabulated below. In the table, P (>5%) indicates the probability of the absolute error of the estimated count exceeding 5 percent.

Table 2

	P (>5%) Direct	**P (>5%) Z-score**	**P (>10%) Direct**	**P (>10%) Z-score**
2010 Semi-Random	28%	27%	3%	3%
2010 Random	6%	5%	<0.5%	<0.5%

2011 Semi-Random	16%	15%	<0.5%	<0.5%
2011 Random	12%	12%	<0.5%	<0.5%
2012 Semi-Random	45%	43%	12%	12%
2012 Random	30%	28%	4%	3%
2013 Semi-Random	27%	26%	2%	2%
2013 Random	14%	14%	<0.5%	<0.5%

The random scheme produced smaller errors than the corresponding semi-random scheme in all cases. However, the semi-random scheme more closely resembles the feasible, fixed schedules given in Table 1. The probabilities of exceeding 10% error seem reasonably small. The worst case is 2012 where the probability is 12%. The estimated errors for the fixed schedules in Table 1 for 2012, however, are all much less than 10%. The only fixed schedule in Table 1 with an error as large as 10% is the late schedule for 2013. This does not mean that the two approaches (semi-random vs. fixed) give contradictory results - the entries in Table 2 are only probabilities. It can be questioned, however, how applicable the results of the semi-random simulations are to feasible, fixed schedules.

In summary, it would appear reasonable to assume that six-hour sampling using something like an alternating schedule based on the best available estimate of the hourly profile would produce counts with errors having a reasonably small likelihood of exceeding 10%. The fact that there are some interpolated and extrapolated counts in the sixteen-hour data sets means that there is less variance in the data than there would be without the interpolation and extrapolation. This would cause the simulations to underestimate the errors due to sampling. The amount of underestimation is probably not large enough to invalidate the summary statement above. As mentioned in the opening paragraph, this analysis only addresses the additional error due to sampling. One of the other sources of error in estimating total predation in the Bonneville tailrace is the fact that there are no observations on the weekends. Weekend predation is estimated by interpolating between the adjacent Friday and Monday counts. An estimate of the error due to this interpolation across days can be obtained by simulation using the same spreadsheets used above for the six-hour sampling. This was done by doing three one-day interpolations and two two-day interpolations. In each of the four years, the counts were interpolated for Tuesday, for Wednesday, for Thursday, for Tuesday and Wednesday, and for Wednesday and Thursday. The counts with interpolation were compared with the counts without interpolation and the relative error determined. The results are shown in the Table 3 below. The mean absolute error for interpolating for one day out of five is 1.4%. The mean absolute error for interpolating for two days out of five is 3.1%. One day out of five represents interpolating for 20% of the five days. Two days out of five represents interpolating for 40% of the five days. The actual estimation of predation counts involved interpolating for Saturday and Sunday, two days out of seven or 28.6% of the seven days. Based on the above, a

way to obtain a rough estimate of the error due to interpolating for weekends would be to take the mean of the two estimates from the simulations or 2.25%.

Table 3

Simulation	Pct. Error
2010-lessT	-0.1
2010-lessW	-1.3
2010-lessTh	1.7
2010-lessTW	-2.8
2010-lessWTh	0.9
2011-lessT	0
2011-lessW	0.3
2011-lessTh	-0.4
2011-lessTW	0.4
2011-lessWTh	-0.1
2012-lessT	-1.8
2012-lessW	-0.3
2012-lessTh	3
2012-lessTW	-4.2
2012-lessWTh	5.5
2013-lessT	0.9
2013-lessW	3.9
2013-lessTh	-3.2
2013-lessTW	9.6
2013-lessWTh	1.4

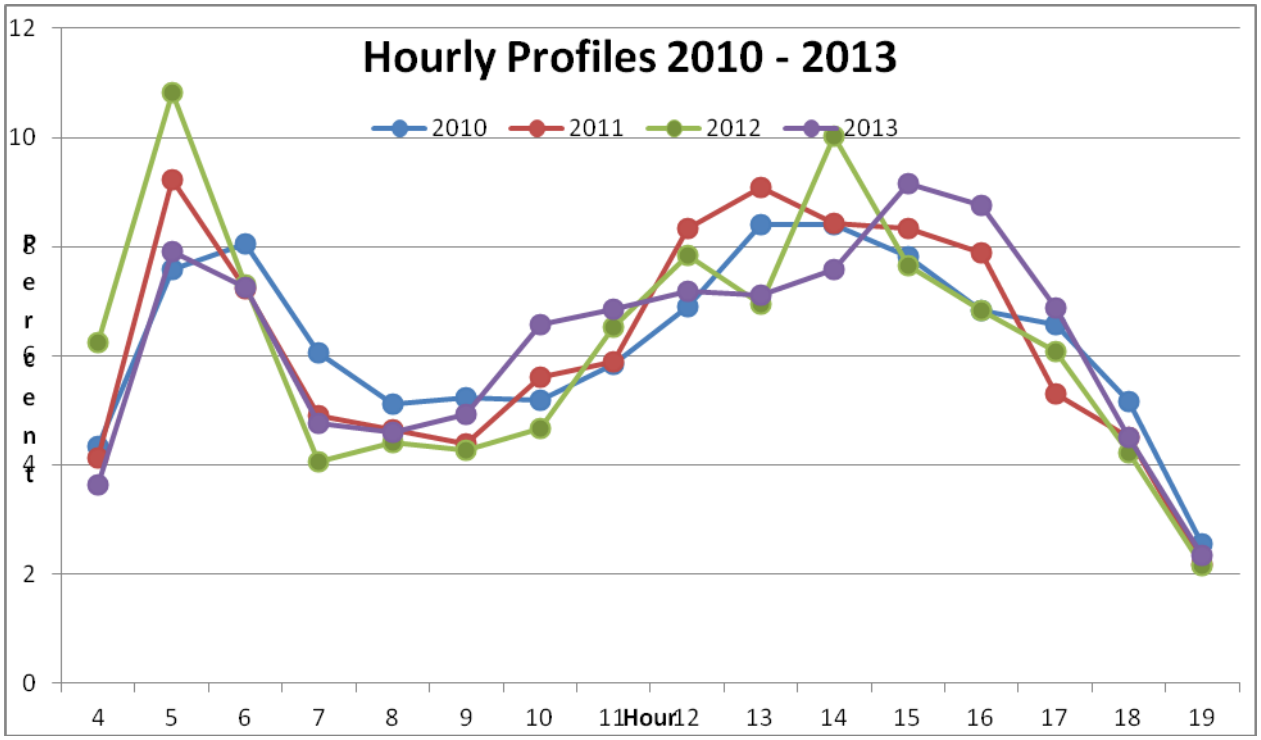
Hourly Profiles 2010 - 2013
2010
2011
2012
2013
Percent
Hour
0
2
4
6
8
10
12
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19

Figure 1

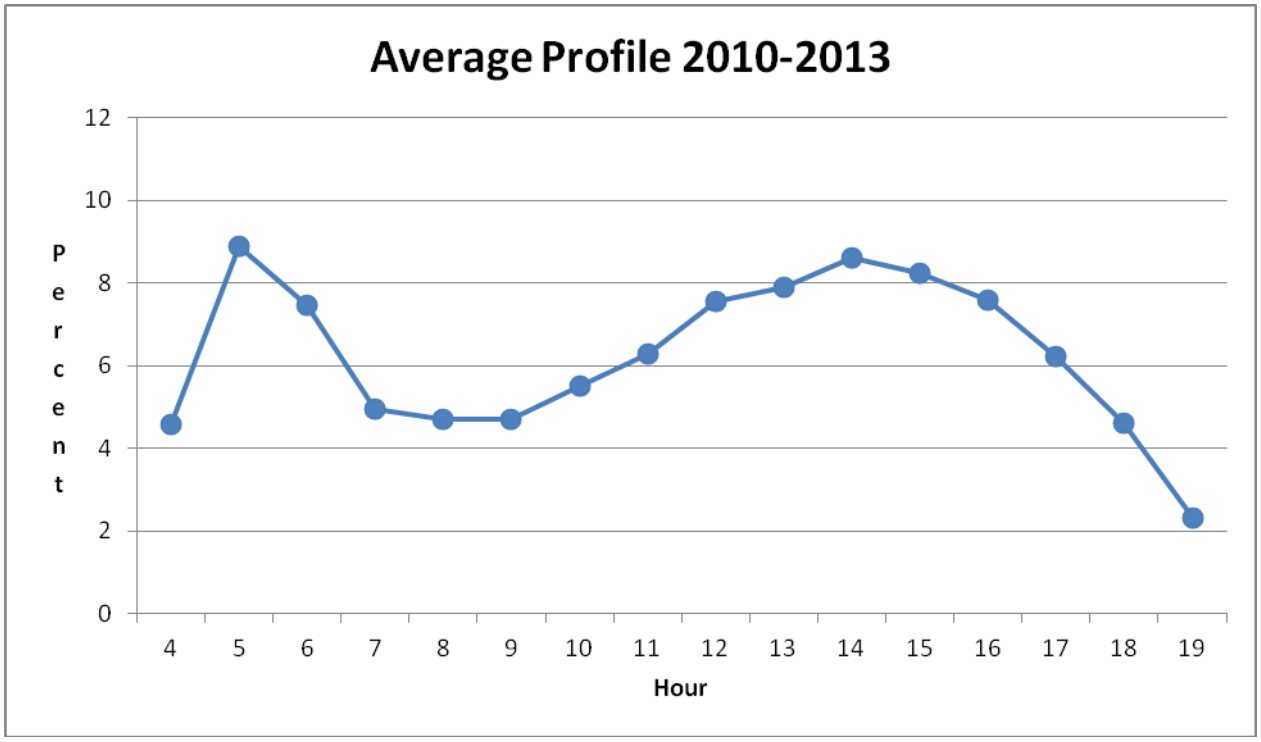
Average Profile 2010-2013
Percent
Hour
0
2
4
6
8
10
12
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19

Figure 2

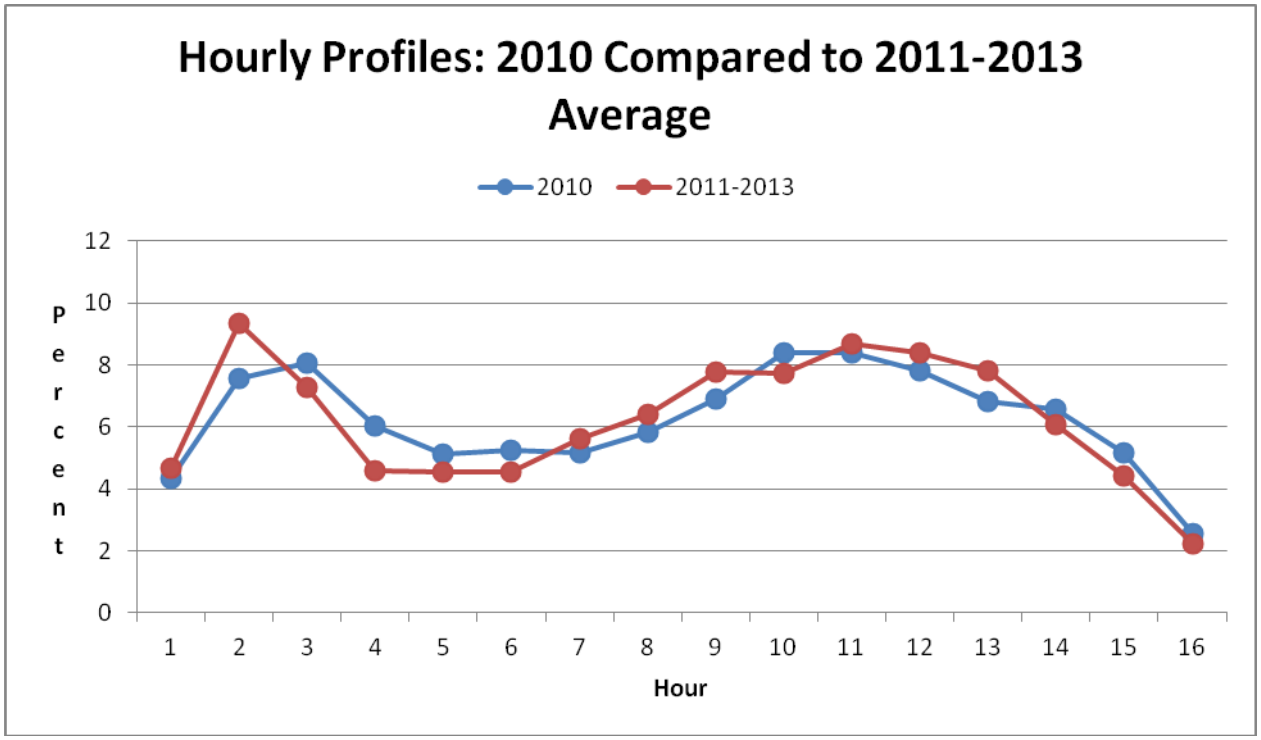

Figure 3

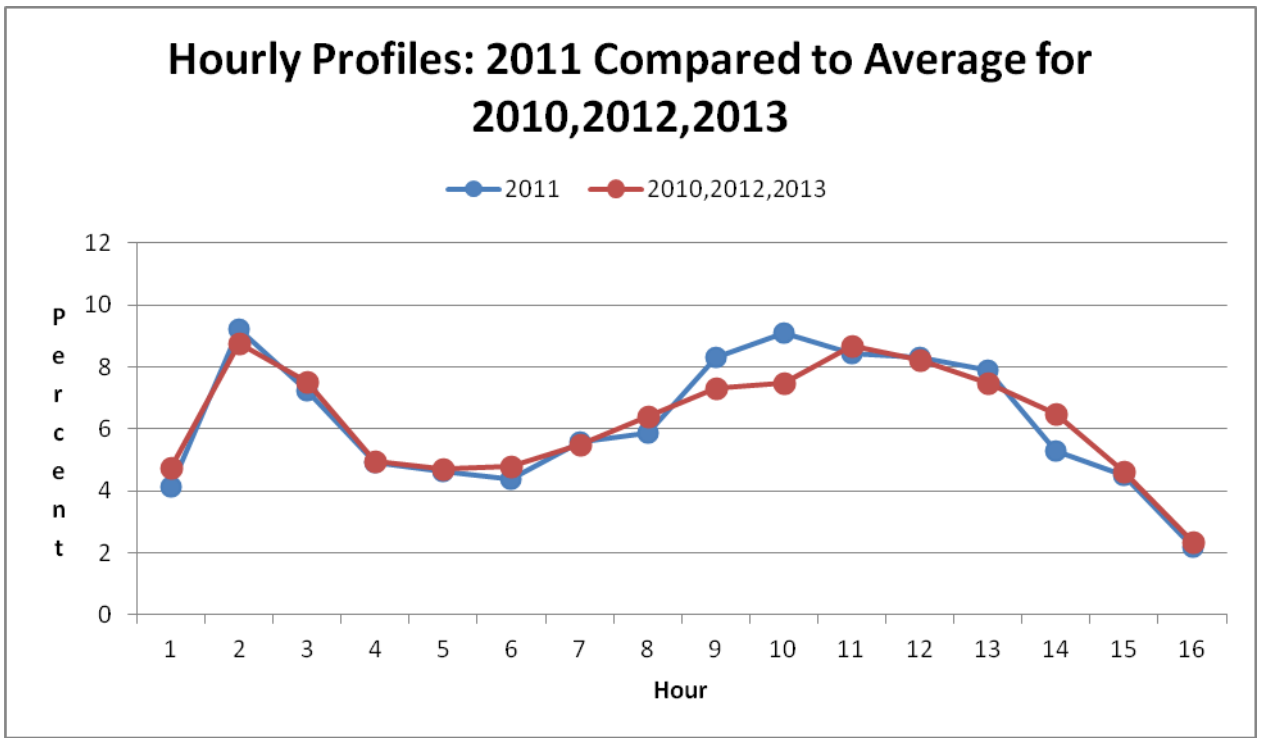

Figure 4

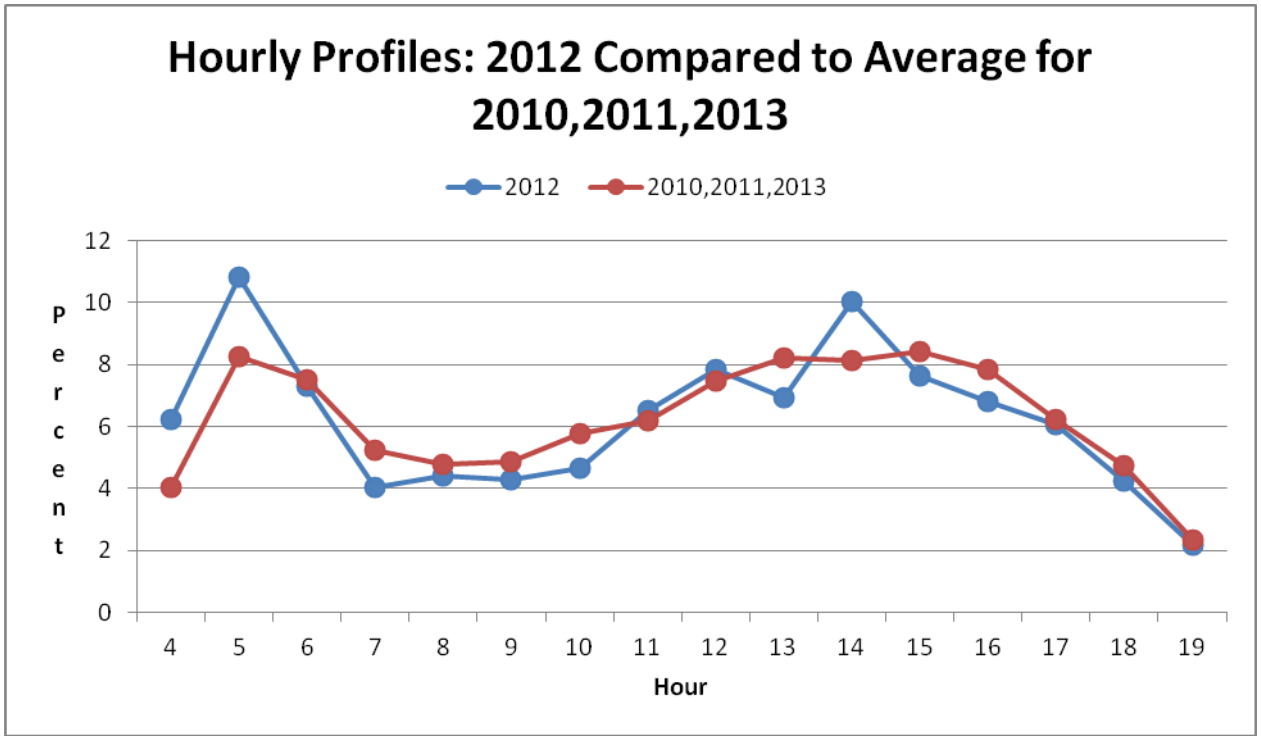
Hourly Profiles: 2012 Compared to Average for 2010,2011,2013
2012
2010,2011,2013
Percent
0
2
4
6
8
10
12
4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19
Hour

Figure 5

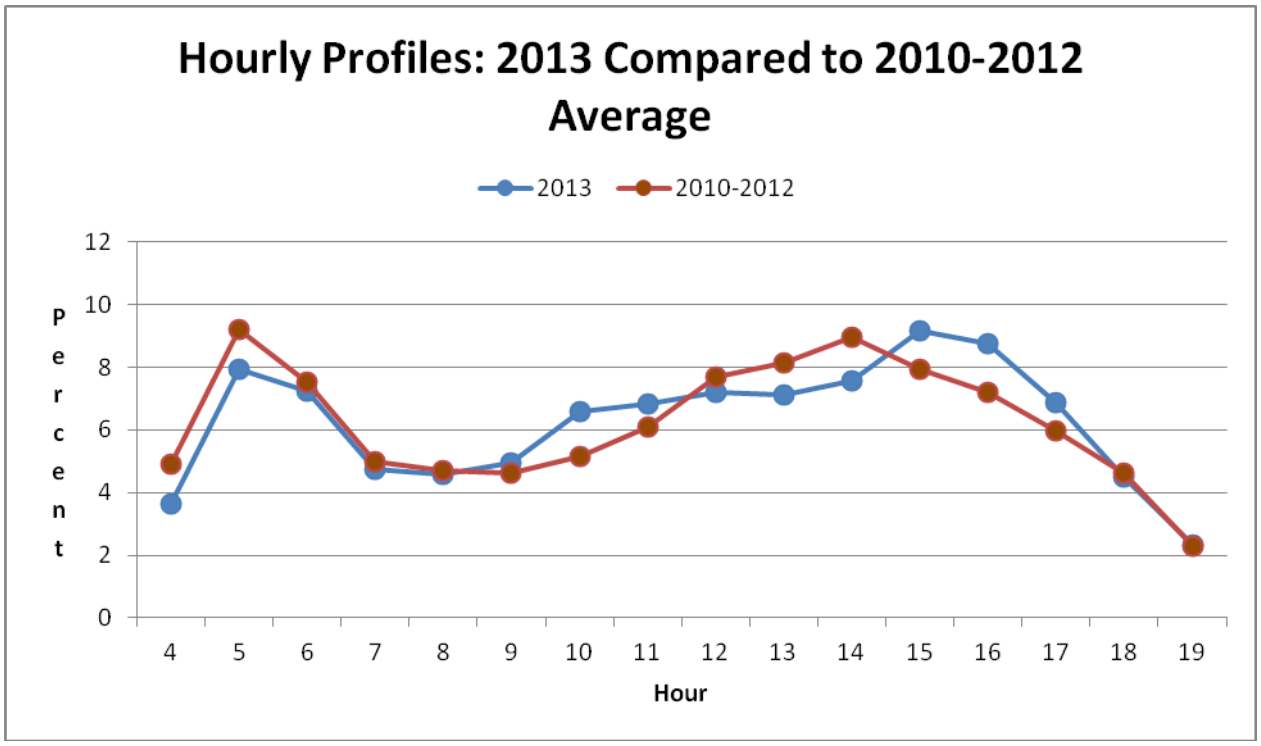
Hourly Profiles: 2013 Compared to 2010-2012 Average
2013
2010-2012
Percent
0
2
4
6
8
10
12
4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19
Hour

Figure 6

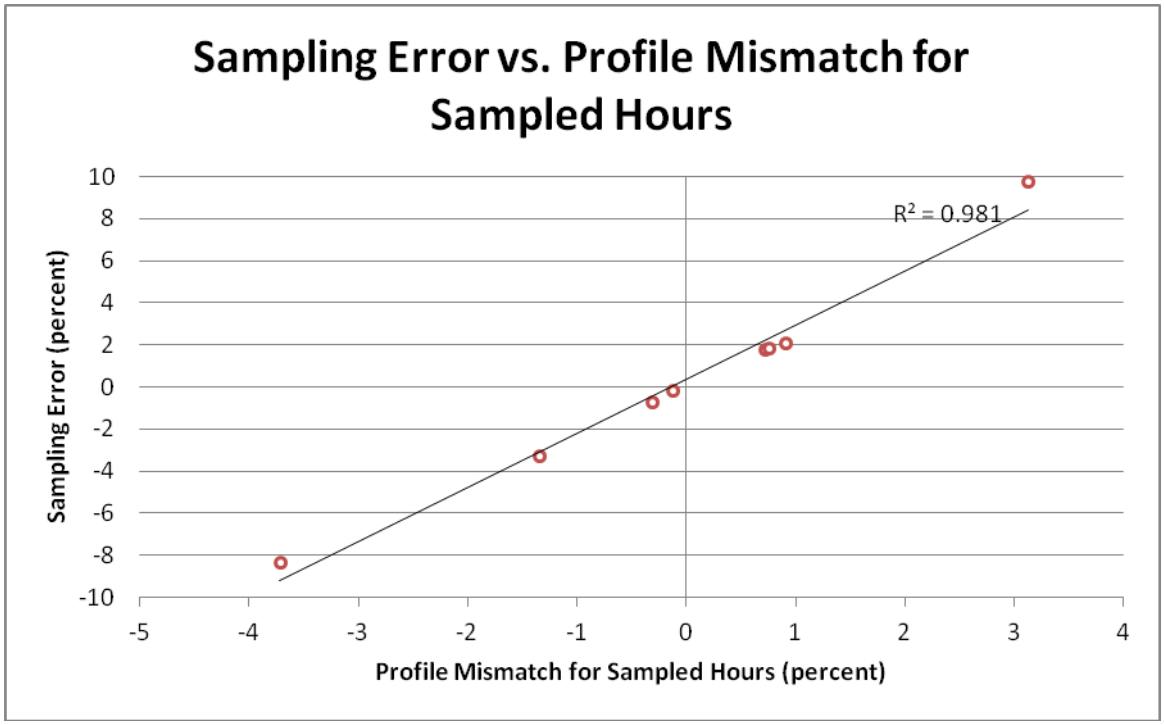

Figure 7

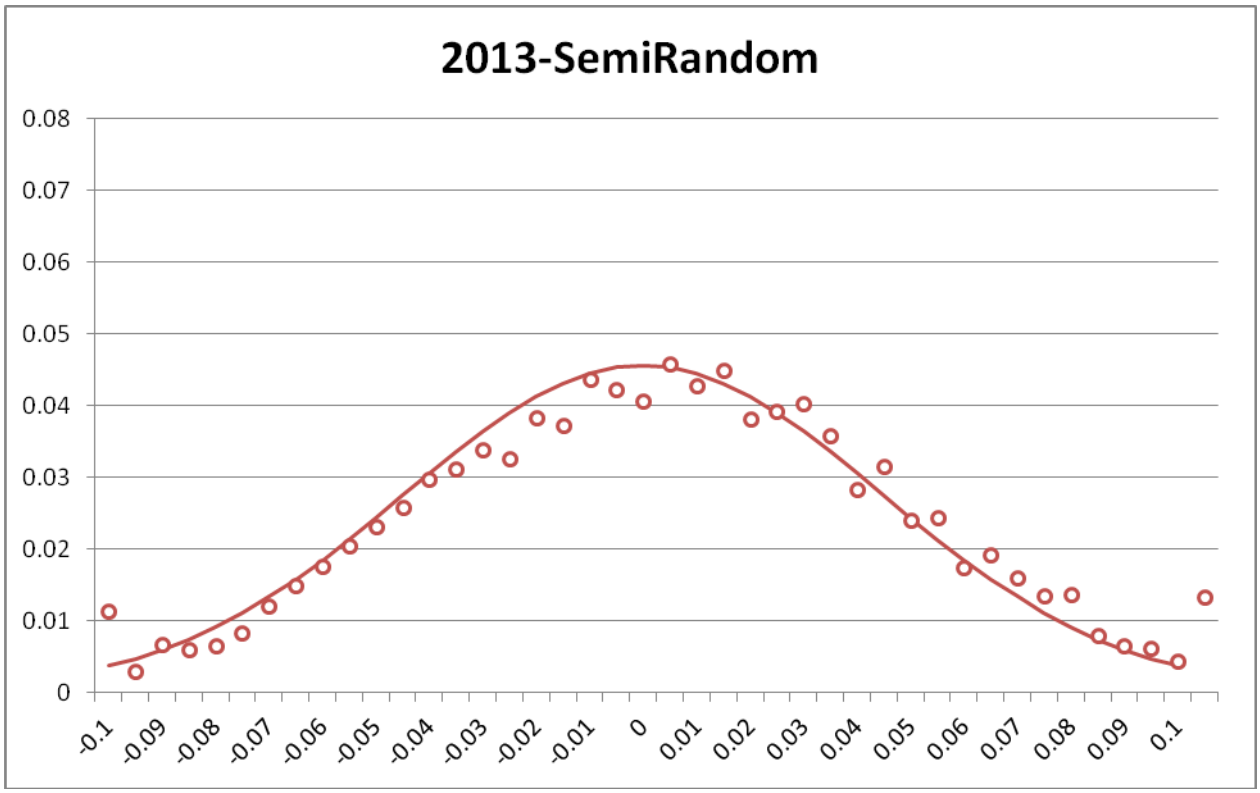

Figure 8

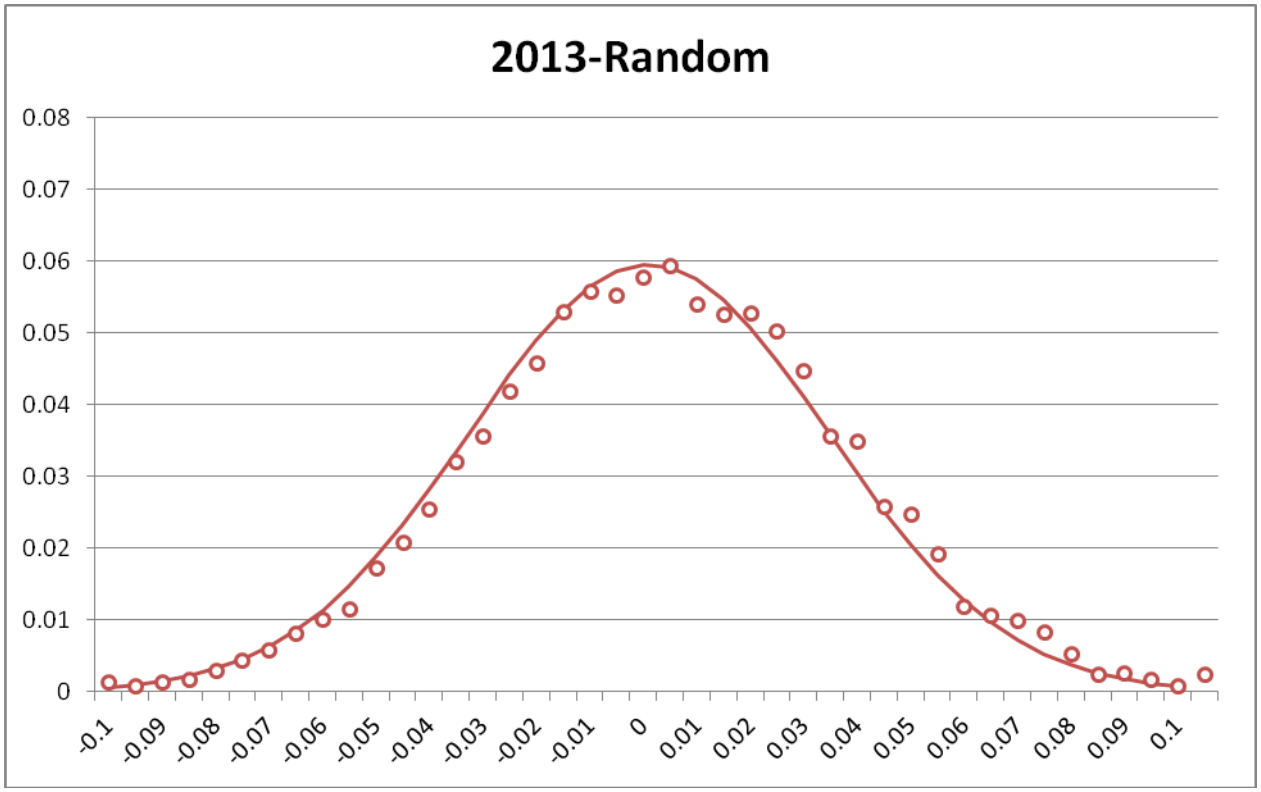

Figure 9