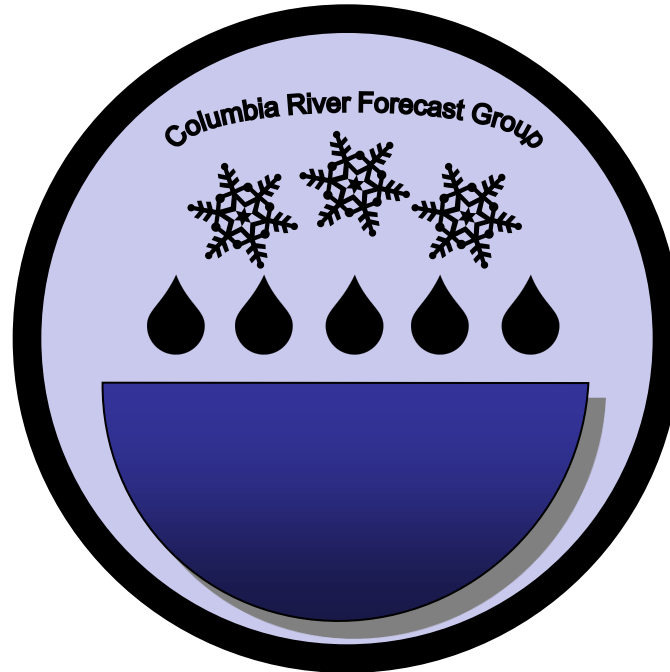


COLUMBIA RIVER FORECAST GROUP

2018 ANNUAL REPORT



CHAIRMEN: JASON WARD, USACE
(1 JANUARY – 31 AUGUST)
MICHAEL WARNER, USACE
(1 SEPTEMBER- 31 DECEMBER)
VICE-CHAIRMAN: PETER COOPER, USBR

24 SEPTEMBER 2019

COLUMBIA RIVER FORECAST GROUP

2018 ANNUAL REPORT

SUMMARY

The Columbia River Forecast Group (CRFG) was created in 2009 to promote and support the advancement of water resource forecasting, products, and techniques in the Columbia River Basin. The primary group objective is to refine and improve Basin reservoir operations for the benefit of the region's water supply consistent with the Columbia Basin Fish Accords and 2008 Federal Columbia River Power System (FCRPS) Biological Opinion (BiOp), Reasonable and Prudent Alternative (#7) as shown below.

RPA Action 7 – Forecasting and Climate Change/Variability: The Action Agencies will hold annual forecast performance reviews looking at in-place tools for seasonal volume forecasts and to report on the effectiveness of experimental or developing/emerging technologies and procedures. As new procedures and techniques become available and are identified to have significant potential to reduce forecast error and improve the reliability of a forecast, the Action Agencies will discuss the implementation possibilities with regional interests. The purpose is to improve upon achieving upper rule curve elevations by reducing forecast errors and thereby providing for improved spring flows...

The Action Agencies and Fish Accord partners collaborated to form the Columbia River Forecast Group (CRFG) to implement this RPA action and to meet Accord principles. To address these needs, the CRFG provided an open forum for sharing, discussing, evaluating, comparing and potentially implementing new forecasting techniques, supporting procedures, and information into the planning and operation of the Columbia River Basin reservoir system. The term “forecasting” refers to both water supply forecasting and streamflow forecasting.

The CRFG developed a charter, organizational structure, expectations, and strategies in 2009. Under the terms of the charter, the CRFG is open for participation from any Basin representative of a governmental organization, academic institution, or invited guests of the CRFG who are willing to contribute to the effectiveness and success of the group.

The CRFG conducted four business meetings in 2018, three of which were hosted by CRITFC: 20 February, 14 June, 26 September, and the annual review hosted by NOAA on 6 December. Each meeting provided a forum to review the current runoff forecasts (or performance), discuss topics of common interest, and to hear speakers on topics related to water supply forecasting. Meetings were attended by staff from BC Hydro, Bonneville Power Administration (BPA), Columbia River Inter-Tribal Fish Commission (CRITFC), Corps of Engineers (COE), Fish Passage Center (FPC), Idaho Power Company (IPC), National Oceanic and Atmospheric Administration (NOAA) Fisheries, Natural Resources Conservation Service (NRCS), NOAA/NWS-Northwest River Forecast Center (NWRFC), Northwest Power Conservation Council (NWPCC), University of Washington Department of Civil and Environmental Engineering, Upper Snake River Tribes (USRT), U.S Bureau

of Reclamation (USBR), U.S. Geological Survey (USGS), and Washington Dept. of Ecology.

TOPICS FOR DISCUSSION

Topics and discussion covered a wide range of interests and included:

- Review and discussion of current forecasts (winter/summer meetings) with a focus on forecast errors and challenges; summaries of snow and precipitation patterns
- Current status of the RMJOC-II Climate Change study, with CRFG serving as a technical body to test and further evaluate study methodologies, and provide supplemental support to RMJOC-II technical workshops and dataset development
- Continued efforts within the hydrologic research community on climate data downscaling, incorporating new and real-time precipitation data into models which were calibrated to entirely different data sources, and better quantifying forecast uncertainty, which in turn is driven by historical observation, meteorology and modeling uncertainties
- Update on NOAA/NWS-NWRFC Initiatives
- Discussion of Verification of Forecast Methods
- The 2018 wrap-up and review of runoff forecasts, comparison of results, discussion of challenges, and lessons learned; and
- Discussion of possible 2019 CRFG activities and work elements

Water Year 2018 was a challenging year for all areas of the Columbia River Basin, but for different reasons. There was a water supply north-south dipole along a dividing line that ran roughly along the Washington-Oregon border. By April, much of Washington, Northern Idaho, and Montana had accumulated well above normal snowpack, while areas to the south were well below normal. Above normal precipitation in the north during the months of February and April helped build a big snowpack in the Upper Columbia, including North-Central Washington (and north of the border in British Columbia) and Northern Idaho/Western Montana. Finally, persistent May warmth very effectively melted the existing snowpack rapidly, causing flooding along the Okanogan River in Washington, the Clark Fork River in and around Missoula, Montana, among other areas. Meanwhile, in the south, several areas struggled with below normal precipitation and snowpack throughout the year.

While there was no dedicated keynote speaker for the year, Jeremy Giovando from the US Army Corps of Engineers, Cold Regions Research Laboratory, presented on two occasions regarding his research on the RMJOC-II Water Supply Forecasting Approach. Using

climate change data, Jeremy presented on methods of broadly-used approaches and the challenges in moving forward with forecasting in a changing climate. Using a new RMJOC-II climate change dataset developed at the University of Washington, Jeremy has been using that data to make new forecasts at locations along the Upper Columbia, with the focus and challenge being the main-stem Columbia. This research is of direct interest to the CRFG and, specifically, to several members of the group which develop the current forecasts for Upper Columbia Projects.

The CRFG was also quite concerned with the possibility of losing some valuable publicly available products from the NRCS due to what appeared to be a staffing shortage. The group, led primarily by Steve Hall and Peter Cooper, drafted a letter of support for those crucial services and the organization in general. The group had an opportunity to hear concerns from members and voice those concerns to the NRCS.

P R E S E N T A T I O N H I G H L I G H T S

Various guest speaker presentations were well received and appreciated by the group:

- ❖ Erik Pytlak, BPA, *RMJOC-II Climate Change Study Updates*: In the February meeting, Erik discussed the big push to get documentation done for the first round of studies and out for peer review. Additional efforts involved conversion of unregulated flow to modified flow, which was work being carried out by the Bureau of Reclamation.
- ❖ Jeremy Giovando, USACE, CRRL, *RMJOC II Forecasting Approach*: In the February meeting, Jeremy talked about his effort to include water supply forecast information in climate change data. He is conducting ongoing research to account for forecast uncertainty in hydro-regulation with the end goal of comparing flood risk differences between hydrology changes with and without seasonal water supply forecast uncertainty. Jeremy described his work and results for point locations during the time periods of the 2030s and the 2070s and reiterated that there is a lot of work left to do in this arena.
- ❖ Jeremy Giovando, USACE, CRRL, *RMJOC II Forecasting Approach*: During the June meeting, Jeremy was back to present recent watershed-level results of work being done on water supply forecasting and climate change. He used precipitation and snow water equivalent (SWE), due to its relationship to flow, mapped to a grid to determine basin averages. There was some discussion revolving around the methodology used, including principal components regression analysis, with an early result being an increase in forecast variability in a climate change future with less snow and higher temperatures.
- ❖ Peter Cooper, USBR, and Steve Hall, USACE Walla Walla, drafted a letter of support for services provided by the NRCS. Due to staffing issues, there was fear that some of the services that the NRCS provides would either degrade or be eliminated. During the December meeting, there was some significant conversation about how to edit this draft to get our point across and who should be representing the group as signatories.

ACCOMPLISHMENTS

CRFG work accomplishments and ongoing studies or issues that will continue to be addressed in 2019 and beyond:

- RMJOC-II. Part 2 of the project are the hydro-regulation studies and these remain underway. Part 1 of the study was completed this year and posted to BPA's website. The CRFG will continue to serve as a technical body to guide the best use of these datasets.
- Climate change continues to be a topic of great interest for the CRFG. The recent comprehensive RMJOC-II dataset provides opportunity for studies throughout the region. Additionally, ongoing discussion continues around the loss of SNOTEL stations contained in current water supply forecasts, but also the potential for future losses of SNOTEL data due to more active fire years on the heels of climate change.
- Continuing to leverage the more frequent period-of-record extensions of the NWS/NWRFC ESP.
- Continuing to monitor the capabilities of remote-sensed snowpack data
- Share best practices between entities on the same CHPS/FEWS modeling platform (NWRFC, BPA, Idaho Power, BC Hydro)
- Continuing to closely monitor both statistical and ESP water supply forecasts for possible refinements.

APPENDIX A

Columbia River Forecast Group (CRFG)

The following pages document the CRFG Charter approved on July 21, 2009.

CRFG CHARTER

I. Purpose

The Columbia River Forecast Group will work to promote and support the advancement of forecasting skill, products, and techniques in the Columbia River Basin for the purpose of improving reservoir operations for the benefit of the region and as prescribed and documented in the Columbia Basin Fish Accords and 2008 FCRPS Biological Opinion, Reasonable and Prudent Alternative (#7). It will also provide an open forum for sharing, discussing, evaluating and potentially implementing new forecasting techniques, supporting procedures, and information into the planning and operation of the Columbia River Basin system. The term forecasting will refer to both water supply forecasting and streamflow forecasting.

II. Composition

The CRFG will be composed of technical representatives from the “Action Agencies” (i.e., AAs), namely the BPA, the USACE, and the USBR, as well as the parties to the Fish Accords. The CRFG will also be open for participation from any representative of a governmental organization, academic institution or invited guests of the CRFG, who are willing to contribute to the effectiveness and success of the group.

The Chair of the CRFG will be a representative from the three AAs or Fish Accord Tribes. The Chair position will rotate annually among these four representative organizations or groups following the Autumn Workshop.

III. Meetings and Workshops

A general business meeting will occur no less than quarterly but more frequently if workload and projects require it. Meetings and workshops will be called at the discretion of the Chair.

In addition to business meetings, there will be an Annual CRFG Meeting in the fall to review the performance of various operational and experimental forecast procedures over the previous water year, to report on any new approved procedures being implemented in the next year, and to plan committee work for the coming year.

IV. Functions

1. Facilitate the sharing of information and research pertinent to the improvement of forecasting for the Columbia River Basin, namely in the areas of water supply forecasting, operational streamflow forecasting, data quality and availability, weather forecasting (as it pertains to improving water supply and streamflow forecasting), and climate change.
2. Track and review the performance of current forecasting procedures and techniques, as well as sharing, discussing, and investigating the potential of new forecasting techniques and modeling.
3. When promising research or techniques are discovered and introduced for consideration, the CRFG will develop a strategy for either investigating the potential improvement with available technical staff within the CRFG or provide recommendations or proposals to the AAs for possible funding and support for further research and development.
4. The group will participate in the evaluation of proposed new forecast procedures, models, and techniques and provide recommendations on the incorporation of new procedures into the planning and operation of the Columbia River system.
5. Facilitate the sharing of data, where possible, and the monitoring of the data network and systems which enhance and support the forecasting capabilities of the region. When necessary, the group will provide recommendations on improvements and enhancements to the network.
6. When necessary, the group will plan and facilitate workshops with presenters speaking on current research and forecast projects. The group will also have a role in educating users on forecasting products and on specific focus areas, providing the technical expertise and platform for conducting seminars and workshops on various topics pertinent to the group's purpose.

V. Reporting

1. The CRFG will produce minutes of each official meeting for distribution to the group and for the purpose of summarizing the group's activities and achievements at the end of the year.
2. The CRFG will produce an annual summary of the group's activities, achievements, and recommendations no later than four months after the end of the water year. This report will be the basis for annual reporting required for the Biological Opinion and Fish Accord records.
3. The organization chairing the CRFG will be responsible for meeting notes and annual reporting at the end of the water year.

A P P E N D I X B

Columbia River Forecast Group - 2018 Meetings

The following meetings took place for the CRFG.

20 February 2018

14 June 2018

26 September 2018

6 December 2018 (Annual Review)

Reviewed and finalized Meeting notes are as follows:

February 20th, 2018

Meeting time: 8:30 am – 12:00 pm PST

Location: **Columbia Intertribal Fish Commission (CRITFC), Columbia Room (12th Floor)**

700 NE Multnomah Street, Portland

Teleconference Info

Teleconference: USA Toll-Free: (877)336-1839

ACCESS CODE: 5336759

Web Meeting Address: <https://usace.webex.com/join/jason.m.ward>

Meeting Number(s): (877)336-1839

ACCESS CODE: 5336759

Contact Info: Jason Ward (503-808-3952)
Peter Cooper (208-378-5037)

8:30 am **Welcome and Introductions** (Jason)

8:40 **Approval of December Minutes** (all)

8:45 **2018 Water Year to date (~ 15 minutes each)**

NWS-NWRFC: Kevin Berghoff (or alternate) (systemwide)

NRCS: Gus Goodbody or Rashawn Tama (systemwide)

USACE: Joel Fenolio or Jon Moen (LIB)

Steve Hall (DWR)

10:00-10:15 << **BREAK** >>

10:15 **2018 Water Year to date, Continued**

Reclamation: Peter Cooper (HGH, upper Snake)

BC Hydro: Georg Jost

CRITFC: Kyle Dittmer (TDA)

Others? (e.g. Idaho Power Co.)

11:15-11:30 **RMJOC-II Climate Change Study Update** (Erik)

11:30 **RMJOC II Forecasting Approach** (Jeremy Giovando)

12:00pm **Set next Meeting and Adjourn**

Meeting Minutes

**Columbia River Forecast Group – Winter 2018 Meeting: February 20, 2018
Columbia Intertribal Fish Commission (CRITFC), Columbia Room (12th Floor)
700 NE Multnomah Street, Portland**

Introductions:

Chairman Jason Ward welcomed the group and started the meeting at 8:45 am. The attendees introduced themselves.

Approval of Minutes:

Chairman Ward asked the members to approve the minutes from the December 2017 Fall Forecast Meeting. It was so moved by Peter Cooper and was seconded by Kyle Dittmer and they were approved as final.

2018 Water Year to Date Summaries:

Systemwide – Kevin Berghoff, NWS-NWRFC

Kevin Berghoff gave a summary of the Columbia River basin conditions. Kevin started with a summary of Water Year (WY) 2018 precipitation compared to WY 2017. The Upper Columbia River basin has had strong precipitation so far this year. The Snake River basin is not as strong with the exception of the Upper Snake River basin above Palisades and also the basin above Dworshak. February was a big precipitation month in the Upper Columbia and Dworshak basins. Kevin compared temperatures in WY 2018 to WY 2015 and WY 2017. WY 2018 is so far similar to WY 2015 which was very warm. WY 2018 had a very warm January. Snow conditions were then compared to WY 2017. Last year the southern portion of basin had a big snowpack. This year is the mirror image with the big snowpack in the northern portion of the basin. The Clark Fork is showing near record snowpack this year so far. Observed runoff water year to date was then shown. Above Grand Coulee observed runoff is near normal at 104% of average. Snake River observed runoff is high which indicates we are likely already losing snowpack in that basin. Kevin then showed the ESP water supply forecasts. The Columbia River at Grand Coulee is currently 114% of average, the Upper Snake at Palisades is 120%, Dworshak 125%, Snake River at Lower Granite 108%, and finally Columbia at The Dalles is at 111%. Many of the Snake River tributaries have well below normal forecasts and are feeling the effects of a minimal snowpack.

Kyle Dittmer asked why this winter is so strange. Erik Pytlak talked about the strong MJO signals (organized thunder-storms in Africa move over the Indian Ocean and can influence the jet stream across the U.S.) and associated blocking high. Kyle asked why the MJO is so strong. Erik didn't know but thinks it is playing a factor this winter. The other thing that has been interesting is the Polar Vortex over NE Canada which is abnormal for a La Niña year. California looks very La Niña this year. Jason Ward talked about the persistent high pressure and the so called "dirty ridge." The term dirty refers to some moisture and disturbances being able to come over the top of the ridge. The disturbances have been going up into Canada and then into Montana. Kyle mentioned one thing that was also very unusual was the early December dry and warm spell. Erik noted this is consistent with a strong MJO signature.

Paul Wagner asked Kevin if the 108% forecast for Lower Granite is expected to hold. Kevin stated the Lower Granite forecast includes the Clearwater basin which has been very strong this year which offsets the lower forecast for the Upper Snake at Brownlee. Whether the 108% at Lower Granite will hold up for the rest of the season is unknown and depends on future conditions.

Systemwide - NRCS:

NRCS was not present at the meeting and did not give a presentation.

Libby – Joel Fenolio, USACE

Joel started with the Libby forecast. The snowpack in the Kootenay basin is sitting at approximately 110% of average which is well ahead of last year. Some lower level sites are even reaching record levels. Soil moisture is less than last year because the basin did not have the wet October this year that it had last year. The February water supply forecast for the April-August time period for Libby is 6.7 MAF, 115% of average. The forecast has been consistent this year and has not had the big drop off that was seen in 2017. Joel showed all of the variables in the forecast and mentioned that precipitation is helping to hold the forecast high. In the Kootenay basin there is not a lot of SNOTEL information, so they have to rely on precipitation to help inform what the snowpack might be. Joel mentioned that the current forecast method has been in place for 5 years so it is due for a review. Ryan Lucas asked about the soil moisture index, Joel said it's based on the CPC estimates.

Joel has been looking at how the ESP and the regression methods perform. The RFC has given USACE ESP data. The USACE is looking at the period back to 1984 to stay within the current forecast training period and are looking at the 0 day ESP traces. One thing Joel has noticed is that the ESP's start tracking the actual better than the regression sometime in March or April. Early in the season the regressions are closer. Joel thinks this is because the ESP traces might be tracking basin states better. Regressions tracked better overall for the full period, but he then broke out the data by decade to show the trends in recent years. For the period 1988-1997, the regression performed better. If you look at 1998-2007, regressions were still better. However, in the period 2008-2017, the statistics fall apart with increased variability. Joel showed a few examples. In 2015, the ESP tracked a little better. In 2016, ESP was much better because the regression did not track early runoff. In 2017, regression performed well until April and May. 2017 ended up very dry from late June through September. In 2011, the regression worked well because snowpack stayed. Regression performs better in those situations. WY 2012 was the big year in the Kootenay, and no method could have foreseen 400% of average precipitation. Joel was hoping for a stronger correlation, but found it really depends on the situation you get. ESP works better on the early runoff years. Early season regression in December through February time period is still the more skillful tool. March through May, ESP may be better. It will require professional judgement. If weather conditions are warm, it might be better to switch to ESP.

Kevin asked a question regarding the fact that the regression is tied into treaty. Is there flexibility to go to ESP? Joel noted that a switch would have to be analyzed and would have to be worked through the Columbia River Treaty Hydromet Committee. Jason noted if the conditions warranted, they could do a deviation with a risk analysis. If that begins to happen on a regular basis, they would need to have an update to the water control manual or the water supply forecast. There is some in-season flexibility with deviations. Kevin noted that in the last 10 years there have been more extremes. Kyle added that the variability is astonishing. Mike Warner added that there was much higher variability in December through March, however, April and May don't look that different.

Joel introduced Mike Warner who will be the new USACE Seattle District CRFG representative. Mike has been analyzing the process for capping October precipitation for the Libby forecast. Mike showed that in 2017, October precipitation was 5-6 standard deviations from the mean. USACE ended up capping October 2017 precipitation at 2.5 standard deviations. The question is should they be capping precipitation? In 2017, it was the right decision to cap the precipitation, but there may be scenarios where capping is not the correct approach. More analysis needs to be done, but Mike has taken a very preliminary statistical look at it. He has run a number of standard deviation capping scenarios. The approach was to cap October and November precipitation at various standard deviations, and determine which capping level minimized the error for the April-August inflow forecast. His analysis showed that 1.5 to 2.0 standard deviation cap appears to give

the smallest errors by the April and May forecasts. The outstanding question is whether it is worth capping. Mike has more analysis to do and will write up and present when they have more results.

Joel informed the group that he is leaving USACE and is taking the Realtime Operations supervisor position (Mary Mellema's old position) at the PN Region of Reclamation in Boise. This is going to be his last CRFG meeting as a USACE employee.

Hungry Horse and Upper Snake – Peter Cooper, Reclamation

Peter started with Upper Snake and mentioning the distribution of snow has been interesting with above normal accumulation at high elevations and below normal snowpack in the lower elevations. Peter showed 2015 and 2012 as potential dry scenarios, 2008 and 1989 as average scenarios, and 2017 and 1996 as wet scenarios. High elevation SNOTEL sites started to gain SWE in September and are above average. Mid-elevation sites are fairly normal for SWE accumulation to this point. Low elevation sites are below average. This is opposite to last year's above normal low elevation snow. Peter showed an anecdotal news article from Jackson, Wyoming that showed the national elk wildlife refuge will not be feeding the elk this year because of the lack of low elevation snow. This would be the first time in the history of the program (37 years) that feeding has not occurred. Peter showed about 10% of the area is in the high elevation band (a lot of snow up high, but not much of the area). About 40% of the area is in the mid-elevation band with average snowpack. 50% of the area is in the low elevation band with below average snowpack. Kevin had mentioned earlier the above normal streamflows. Perhaps some of the reason is the low elevation snow already running off. Feb-Jul forecast of 3,900 KAF (109% of average). The forecast has been pretty consistent so far this winter. Reclamation coordinates the forecast with the Corps each month to develop an operating forecast.

Peter then talked about the Hungry Horse forecast. The story is the big snowpack so far in northwest Montana. Peter mentioned that fires last summer burned Badger Pass SNOTEL, which is one of the best correlated sites we had for forecasting Hungry Horse. Other SNOTEL sites are also having issues, and with the weather, no snow course flights have been able to occur. Therefore, Reclamation is working with a lot of estimated information for the sites that go into the forecast. NRCS has been helping produce estimates of SWE at missing sites. Peter showed Noisy Basin SNOTEL, this year we are near record high SWE for this time of year, 2011 and 1997 are the only years with higher snow accumulation. We have already hit the peak accumulation for the season 2 months ahead of normal. Low elevation snow is present, unlike the Upper Snake. February has seen some big storms and the forecasts have increased. February forecasts: 2,474 KAF Feb-Jul (122% of average) and 2,062 KAF May-Sep (122% of average). Early indications are March forecast will increase as snowpack has increased. RFC is also showing the increase in forecast.

Kyle mentioned the stair-stepping nature of snow accumulation this year. Pete mentioned we have been getting big storms and then clearing period after the storms.

Dworshak – Steve Hall, USACE

Steve presented the February forecast for Dworshak at 2.85 MAF. The issue once again this year is the precipitation stations. They are having problems with missing data because of snow bridging on the gauges. They are in the process of relooking at the water supply forecast and potentially cutting out precipitation before January. In addition, two of the SNOTEL sites, Elk Butte and Cool Creek, are out of service and there has not been a window to fly in to make repairs at those stations. Therefore, out of 6 indicators in the Dworshak forecast, 3 are being estimated. RFC's forecast has increased. Steve showed an early bird March forecast of between 2.5 and 3.2 MAF. The final March forecast will depend on how the storms come through for the rest of the month. Kyle had made a comment earlier regarding the large stair stepping of snow accumulation.

Steve doesn't think it is too abnormal to get stair stepped accrual of snow. Typically you will get a storm and then it clears up, so it is not surprising to see the staircase. The biggest uncertainty is what the future weather will do.

Jason asked if there are any instrumentation improvements that can help with snow bridging. Steve stated that without AC Power, there isn't much you can do. It is hard to get the amount of power you need to help things with just a battery bank and solar panel which typically don't do well in cold and snow. Steve did say that with sites that have a snow pillow, you can adjust the precipitation with what you see at the snow pillow, but a full scale SNOTEL site costs roughly \$25k for the installation plus \$8-10k of operating cost per year.

Mica, Arrow and Duncan - BC Hydro

BC Hydro was not present at the meeting and did not give a presentation.

Kyle Dittmer – CRITFC

Kyle showed his curvilinear regression between MEI and The Dalles runoff. Based on the January ENSO update, the index hit its most negative point in January. It is likely La Niña will continue through late winter and into early spring. Kyle's latest MEI method returned a The Dalles forecast of 108 MAF for the January - July time frame which is 107% of average, 87 MAF for the April - July time frame which is 109% of average, and 95 MAF for the April - August time frame which is 109% of average. Kyle stated that this is in line with what the NWRFC shows for their The Dalles forecast. Kyle also showed his ONI analysis which resulted in 110 MAF Jan.-July, 88 MAF April-July, and 96 MAF April-Aug.

Kyle is predicting five snow events for Portland. Today is the 4th event in Portland. Generally when we move past mid-February it gets too warm to get a low-elevation snow event.

John Hildreth – Idaho Power Company

John presented the forecast for Brownlee which is sitting at 101% of normal. About 1/5 of that is regulated flow from Milner. John noted it will be interesting to see how the basin above Milner plays out. Brownlee is already at its end of February target and is nearly to where they need to be end of March. They are essentially passing inflow at this point. The southern portion of the basin as well as Boise/Payette/Weiser are very dry. They aren't expecting too much runoff out of those basins. The Upper Snake is the wild card.

Pete added Palisades will probably need to start flood control operations in March. Recharge and early irrigation demand could have impact on how much water goes past Milner.

Erik Pytlak - RMJOC-II Climate Change Study Update

Erik began by mentioning Bart Nijssen, Oriana Chegwidan and David Rupp have earned the BPA Administrator Excellence Award for Exceptional Public Service. This is the highest award BPA gives. This award is to recognize them for all of the climate change work they have done over the past 4 years. They will be at BPA on April 25 for an awards presentation. The group gave a big congratulations to them.

Documentation for first round of study is underway. Progress is being made. Erik anticipates RMJOC level review in March, and April it will be released for draft, with finalization by late May. The goal will be to get the draft to 80% and send it out for comment and peer review in April (CRFG). The report will not include anything in the hydroregulation piece because this hasn't started yet. Conversion from unregulated to modified flow like is underway. Reclamation has been working on this. Later this spring, we will have all of the pieces we need to do the hydroregulation studies. Jeremy Giovando has been working on the forecast component.

Next time we have CRFG we will be actively discussing the first report.

Jeremy Giovando - RMJOC II Forecasting Approach

Jeremy has been working on water supply forecasting development with climate change data. Locations for the most part are focused on storage projects. The objective is to include forecast uncertainty in the hydroregulation study in order to compare flood risk differences between hydrology changes with and without seasonal water supply forecast uncertainty. Conceptually this is pretty straight forward, however, implementation takes more thought. There is agreement that constant forecast error would be used for 2030s and 2070s. The modified like flows will be basis for how they develop forecast and statistical procedures similar to how seasonal forecasts are currently developed will be used. Many forecasts are being developed. The steps are:

- 1) select forecast metrics
- 2) choose method
- 3) select input data (limited to what is available)
- 4) create scripts
- 5) validate test forecasts (**current status**)
- 6) generate forecasts

Currently looking at relationship of SWE and flow in the different watersheds. Jeremy is seeing interesting results in how those correlate. They are not trying to actually recreate historical forecast error, rather they are using historical forecast error as a benchmark. Early hypothesis that error will increase in the future using the statistical methods. Continuing to investigate that hypothesis and getting closer to being able to answer that. Example: error did increase in the 2030-2059 training period. Focus in on Dworshak. About 2030s see divergence on where amount of March 1 SWE changes dramatically although don't see same shift in total flow. What that means is more runoff is being produced by rain rather than snowpack. This will impact statistical error but the question is how much. Chose to use aggregated spatial files. Taking SWE grids from VIC model and calculating total SWE above forecast point. Doing that for accumulated precipitation throughout the water year as well. What that does is allows us to identify if we know inputs are perfect, how much does forecast error impact flood risk. Even with perfect knowledge of basin conditions, get different responses based on future conditions. Erik mentioned that is an excellent point that precipitation forecasts might get more uncertain. But when talking snowpack as it gets more and more variable from year to year, the hypothesis sounds good and the numbers Jeremy is seeing so far make sense.

Jeremy mentioned there is a spectrum of real world vs. research. What they chose was to stay more on the operational side and look at aggregated variables and point to grid locations. The thought was to go with what we have today – point locations. They will also be looking to document why they chose 30 years vs. some other period.

Next challenge will be how to develop forecasts for the mainstem; directly forecast it or aggregate sub basins. Direct relationship between SWE above The Dalles vs. volume matches fairly well. May have ability to just develop forecast for The Dalles based on upstream parameters.

An additional challenge is how well can we predict Brownlee because dealing with regulated flows. This has the effect to start to decouple hydrology from actual snowpack conditions. Actual correlation is fairly low for snowpack vs. actual volume, but when they look at the forecast, the forecast is within realm of actual operational forecast error. Even though correlation is low, that is true today. May not be an issue after all. Will need to explore more of the datasets to see if that result holds true.

Joel asked why was the 1976-2005 training period chosen? Jeremy stated that when UW was originally delivering hydrology, there was a discontinuity at 2006 so the decision was made to stop at 2005 and go back 30 years. Joel mentioned at Libby there are strange years after 2005 that aren't being included. Jeremy mentioned that the data still only goes to 2011 so that might not even address the years Joel mentioned. Erik stated that is a tough call because also comparing climate change world to real world also so might not be a 1:1 anyway.

Jason asked what software is being used. Jeremy said that R is being used.

Adjournment:

The next CRFG meeting will be scheduled, TBD, by Jason Ward and sent out to the CRFG to likely coincide with other TMT or RMJOC meetings to accommodate traveling schedules. The meeting was then adjourned.

Attendance:

In person

Jason Ward - USACE
Michael Warner - USACE
Joel Fenolio - USACE
Logan Osgood-Zimmerman - USACE
John Hildreth – IPCO
Geoffrey Walters – NWRFC
Ryan Lucas – NWRFC
Amy Burke – NWRFC
Kevin Berghoff – NWRFC
Stephen Hall – USACE
Kyle Dittmer – CRITFC
Peter Cooper – Reclamation

On phone

Erik Pytlak - BPA
Paul Wagner – NOAA Fisheries
Leslie Bach – NW Power and Conservation Council
Jeremy Giovando – USACE
Sherri Sears – Colville Tribe

Note Taker: Peter Cooper, CRFG Vice-Chair, U.S. Bureau of Reclamation, Boise, Idaho

June 14, 2018

Meeting time: 8:30 am – 12:00 pm PDT

Location: **Columbia Intertribal Fish Commission (CRITFC), Columbia Room (12th Floor)**

700 NE Multnomah Street, Portland

Teleconference Info: USA Toll-Free: (877)336-1839

ACCESS CODE: 5336759 Security Code, if needed: 1234

Web Meeting Address: <https://usace.webex.com/join/jason.ward>

Meeting Number(s): (877)336-1839

ACCESS CODE: 5336759

Security Code (if needed): 1234

Contact Info: Jason Ward (503-808-3952)
Peter Cooper (208-378-5037)

8:30 am **Welcome and Introductions** (Jason)

8:40 **Approval of February Minutes and 2017 Annual Report** (all)

8:45 **2018 Water Year to date (~ 15 minutes each)**

NWS-NWRFC: Kevin Berghoff (or alternate) (systemwide)

NRCS: Gus Goodbody or Rashawn Tama (systemwide)

USACE: Mike Warner (LIB)

Steve Hall (DWR)

10:00-10:15 << **BREAK** >>

10:15 **2018 Water Year to date, Continued**

Reclamation: Peter Cooper (HGH, upper Snake)

Idaho Power: John Hildreth

BC Hydro: Georg Jost

11:00 **“The Sampler” Salmon Manager Topics?** (Paul Wagner), Misc

11:15-11:30 **RMJOC-II Climate Change Study Update** (Erik Pytlak)

11:30 **RMJOC II Forecasting Update** (Jeremy Giovando)

12:00pm **Set next Meeting and Adjourn**

Meeting Minutes

Columbia River Forecast Group (CRFG) – Spring 2018 Meeting: June 14, 2018
Columbia Inter Tribal Fish Commission (CRITFC), Columbia Room (12th Floor)
700 NE Multnomah Street – Suite 1200, Portland, Oregon

Introductions:

Chairman Jason Ward welcomed the group and started the meeting at 8:35 am. The attendees introduced themselves.

Approval of Minutes:

Chairman Ward asked the members to approve the 2017 CRFG Annual Report. It was so moved by Steve Hall and was seconded by Kyle Dittmer and the 2017 Annual Report was approved as final.

Chairman Ward asked the members to approve the minutes from the February 2018 Winter CRFG Meeting. It was so moved by Erik Pytlak and was seconded by Steve Hall and they were approved as final.

2018 Water Year to Date Summaries:

Systemwide – Kevin Berghoff, NWS-NWRFC

Kevin Berghoff gave a summary of the Columbia River basin conditions during Water Year (WY) 2018. Precipitation during WY 2018 was distributed such that the northern and eastern basins received more precipitation than the southern and western basins. Temperatures this year started warmer, so WY2018 did not have as much of a jump on snowpack like WY2017. Early April snowpack showed big accumulations in the northern and eastern portion of the basin. There was a sharp contrast between very low snowpack in Oregon and southwestern Idaho versus very large snowpack in northwest Montana with some stations in the Clark Fork basin in NW Montana showing near or above record snowpack. April 4 was the approximate peak snowpack in WY2018. Warm temperatures in May led to high snowmelt rates.

Observed runoff through May was shown. Runoff was strong most of the year, and particularly in May with the warm temperatures and rapid snowmelt. Current ESP April-July forecasts show well below normal streamflow runoff in Oregon and southern Idaho, and at-or-above normal through the rest of region. Upper Columbia runoff ranks in the top 10 for the period of record. The evolution of the ESP forecasts during WY2018 was shown. ESP forecasts increased at first with early season precipitation, and then dropped off with drier conditions in December and January. February came in strong and the forecasts continued to rise through May. Current residual forecasts indicate below normal runoff might be expected going forward as much of the runoff has already passed. NOAA/Climate Prediction Center climate outlooks for all time horizons are showing above normal temperatures and below normal precipitation. So, the ESP forecasts are likely to continue to drop.

Kevin pointed out an interesting condition in the Upper Snake. Early season forecasts in that basin were showing above normal due to high residual soil moisture from the wet WY2017 season. Precipitation in the Upper Snake was about normal. Kevin wants to look into whether high soil moisture at the beginning of the year should result in above normal forecasts to start a season. Erik brought up the fact that the Upper Snake reservoir system was very full at start of year, so the Brownlee forecast was also high to start with.

Kevin also discussed the residual effects of using one model (ESP) to generate both short and long-term forecasts. During times of flooding, NWRFC has to adjust the model to keep the simulation in line with observed. This results in artificially inflating the long-term volume

forecast. As the flood event passes, the NWRFC dials things back and the runoff volume forecasts decrease. One thing that they try and do to mitigate the effects is a snow analysis on a weekly basis or more frequently as needed. Typically, when ramping up to events, the NWRFC is having to increase soil moisture which results in abrupt changes in the forecast. To see these abrupt changes, you can look at the ESP 0-day forecasts. Kevin showed the example of the Libby forecast in late May and June which showed steps in the forecast. These steps were caused by snow and soil moisture changes in the model. NWRFC staff has discussed whether they should separate long and short-term models, however, they think it may cause more issues than it solves. Kyle asked how often does NWRFC make adjustments to its snowpack estimates? Kevin said daily and showed the example that the 1st of month forecasts look pretty stable, but if you look daily, things bounce around a lot. That is the nature of a daily forecast.

Kevin then showed Columbia at The Dalles actual runoff - this is the second year in a row that it has reached over 500 kcfs. Erik added that the unregulated calculation showed a peak unregulated flow of 900 kcfs at The Dalles, and an unregulated flow of 800 kcfs for more than two weeks. Without the FCRPS, Portland would have flooded.

Gus Goodbody asked about reservoir carryover effect on forecasts. Kevin stated reservoir carryover isn't an issue in most basins, however, for Brownlee it does have an impact due to the operation of Milner upstream. Kevin would like to work with Idaho Power Co. and Reclamation (USBR) over the summer to discuss the Brownlee forecast.

Systemwide – Gus Goodbody, NRCS:

Gus highlighted the record snowpack in the Clark Fork and the record May runoff throughout much of the system, including a record at The Dalles for May runoff volume. This is significant. NRCS produces long range forecasts using statistical modeling, so they don't have the same issues that Kevin pointed out with the ESP method. Gus did mention that in June the statistical models have a lot of issues with the guidance consistently too high for the future period.

Gus discussed that the NRCS forecasts went from well above average May-July to below or well below average June-July in many of the headwater basins. This indicates that for the rest of the summer we are likely facing diminished flows with much of the runoff occurring in May. Gus also mentioned that NRCS appreciates having the ESP guidance to look at and based on the issues NRCS was having with their forecasts in June, they issued forecasts much more in line with what ESP was showing backed up with a recession analysis.

Gus then brought some NRCS Agency related news to the group. In the NRCS forecast group, Dave Garen is retiring at the end of July. Dave has been working on statistical modeling for a long time so he will be hard to replace. Gus then pointed out that NRCS is having trouble rehiring people. After Dave's retirement, the NRCS forecasting group will be at half-staff. Typically, there are four forecasters, but they will be down to two. Rashawn Tama who has been forecasting for two years is now in a new position within the NRCS so he won't be forecasting next year. Chris Brown will be taking over the Snake Basin and much of Oregon.

In spite of staff being reduced, NRCS has efforts going to look at improving forecasts including machine learning and ensemble forecasting. Gus pointed out that relying on a single forecast may not be the best approach, and will be looking at how to capture information from different forecasts. Perhaps it will be something more like they used to have when they coordinated with the National Weather Service as there are advantages to having multiple forecasts. In the last few years NRCS has gone from full coordination to no collaboration and Gus would like to see a shift back to somewhere in the middle. Kyle asked if NWRFC and NRCS could once again coordinate? Gus didn't think it could happen like it used to, but perhaps there could be some sort of ensemble

mean forecast. In theory maybe even coordination with the Corps or Reclamation could occur. Kevin thought a big driver for coordination is that the public wants one number from the government. Giving more than one forecast gets confusing, but it does provide valuable information. In addition, some users are required to use a certain forecast. Water users want all kinds of things, so the tricky part is pairing what is available with those needs. The public also has a hard time dealing with uncertainty and how to incorporate that into their plans. Gus would like to get to a place eventually where they can spend more time on analysis of results rather than the development of the tools. There are compelling moments that professional judgement is needed.

Gus further discussed the issues NRCS is seeing with hiring. They simply can't get the people to do everything they need to do. It is not a budget issue and there is Congressional support for their program. The issue is with the agency's rules on hiring at the USDA level. Part of problem is they are a regional program and national programs get more attention. NRCS has made the announcement that some of the maps and products are threatened due to IT support issues that make it difficult to produce those products. Almost every day there is some new problem on the IT side and IT staff has been trimmed. For now, data collection is the highest priority. Gus thinks the best approach is to get the message out repetitively. The budget is fairly stable -it is mostly a people issue. The group was sympathetic and offered to provide any assistance they can as the work NRCS does is invaluable to this group's mission.

Libby – Mike Warner, USACE

Mike has taken over for Joel Fenolio who moved to Reclamation's Pacific Northwest Region. Mike showed a precipitation summary similar to what Kevin showed earlier. The Kootenai basin started off with above normal precipitation and had a really dry May. It was relatively cold early and then came a warm/wet January. Snowpack built through April. May was extremely warm. Snowpack ran off extremely quick in May. Corps has been very busy with flood assistance in the Clark Fork and Okanagan basins. The Corps was also concerned about Libby as well, especially downstream near Bonners Ferry. However, flows came in just under flood stage there. The main story is how fast the snow declined. Mid-April showed 140% of normal snowpack. By mid-June, the snowpack was down to 88% of normal. The current April to August runoff forecast is now at 7.2 MAF. The statistical model has been pretty steady but did jump up in February with wet conditions. The actual runoff volume in May was 3.1 MAF, which is very high. Mike showed the evolution of the ESP traces throughout the season. The ESP traces declined with a dry December. The average-to-above average precipitation in January allowed recovery of the forecast. February through early April had wet conditions and then a very dry and warm May brought the forecasts back down. Monthly flows were below the 30-year average for October-April and then came the huge May runoff. May was the highest runoff since 1961 and was the 9th highest month on record. All of the other highest months on record occurred in June. June is typically the largest runoff month. The current projections show below normal runoff conditions now through September.

Kyle pointed out that June thunderstorms have been an issue in years past. Mike said that we are on the tail end of the snow but that doesn't mean we are out of the woods. June thunderstorms can occur late in the month. Kyle also mentioned the potential for wrap-around storms from the northern Great Plains/northern Rockies and how those have seemed to have happened more frequently in the last five years. Mike said that in the last month or so, they were concerned with snow runoff and filling too fast, however, now they have shifted gears towards looking out for thunderstorms and filling the reservoir. Kyle asked how applicable are the operational curves with changing conditions? Jason answered that it is hard to deal with late rain.

Hungry Horse and Upper Snake – Peter Cooper, Reclamation

Peter started in the Upper Snake basin by showing data from the Lewis Lake Divide SNOTEL site which is typically a good indicator of what the runoff will be like in that basin. Lewis Lake Divide

had an above average snow accumulation year, with a rapid melt off in May as described by other presenters. This led to the 3rd largest May runoff on record of 1,722 KAF which is 164 percent of the 1981-2010 average. In comparison, the very large 2017 water year had the 5th largest May runoff on record of 1,614 KAF. Peter showed unregulated flow for water year 2018 and 1928 which had nearly identical hydrographs. Unfortunately, not much is known about the snow conditions in 1928, but records do indicate it had record heat in May. It is interesting that similar hydrologic conditions can be found in the record. The water supply forecast progression through the season was shown for the Snake River at Heise. The NWRFC tended to come in with higher forecast and the NRCS tended to come in with lower forecasts. The Reclamation/Corps coordinated forecasts came in somewhere in between. Reclamation and Corps forecasts were matching up fairly well this season.

Peter then described the conditions seen at Hungry Horse this year. Peter showed a graph of the snow accumulation at Noisy Basin SNOTEL for water years 1981 to 2018. Water Year 2018 showed a near record high accumulation on par with the large water years of 1997 and 2011. It also showed a similar rapid melt in May. Hungry Horse saw the largest May runoff on record (1,540 KAF => 216 percent of the 1981-2010 average). The second largest May runoff on record was 1928, which similar to the Upper Snake, had a nearly identical hydrograph as Water Year 2018 in the Hungry Horse basin. The progression of the water supply forecasts this year were shown. A steady increase in forecast was seen from the January to May forecast. With the rapid melt in May, the statistics fell apart in June and the forecasts began to vary significantly. Overall it was a very large and exciting year in the Flathead, but no major flooding occurred thanks to flood risk management (FRM) operations at Hungry Horse.

Dworshak – Steve Hall, USACE

Steve started by showing the February runoff forecast for Dworshak of 2.85 MAF. February is when things started to change. March increased to 3.18 MAF due to wet and cold March conditions. The April, May and June forecasts all settled in around 3 MAF. Forecast performance was fairly steady this season. Steve mentioned that they are still having issues with some of the data sites used in the forecast. Shanghai Summit was logged in 2016 and is very barren. The logging company has not replanted. Steve discussed the discrepancy between snow flights and modeled snow-covered area from NOHRSC. NOHRSC was showing 20% snow covered area - they actually saw 7% in the field.

Steve then discussed how weather models in the Clearwater basin in May were overestimating areal coverage of thunderstorms. Erik mentioned that GFS is a 20-km residual model and convection is very difficult.

Steve then discussed the hardships NRCS is having with staffing and echoed comments made by Gus earlier. Steve mentioned that NRCS essentially asked the Corps to cut snow flights, not due to money, but because of staffing. This has a very real impact on operations. Steve offered to take the lead on drafting a joint letter from the CRFG members in support of the NRCS. The joint letter would then be sent to the appropriate official. After a short discussion, the group determined this type of action would be within the group's authority and that the letter should specifically state the purpose of CRFG as outlined in RPA 7. Gus offered the best approach may be to first talk with Mike Strobel, head of the NRCS Water and Climate Center and manager of the snow survey program. Dr. Strobel may be able to offer guidance on who the best person to address the letter to would be. The group was in full support of this action item. Steve will work on the getting a draft of the letter out to the different agencies.

Brownlee - John Hildreth, Idaho Power Company (IPCo)

John described how differently distributed the snowpack was this year compared to 2017. The southwest portion of basin was really dry, with the Payette, Boise, and Weiser basins in the 70-80% of normal snowpack. It was also an interesting year with the large amount of carryover in the Upper Snake River reservoir system from the 2017 season. John described how carryover in the systems above Brownlee along with operations at the upstream projects can greatly change the Brownlee forecast number used in FRM.

The FRM draft for Brownlee this year was very close to that required in 2017 even with much drier conditions in much of the basin above Brownlee. This was due to a combination of the NWRFC Milner forecast (which incorporated high upstream reservoir carryover) and the The Dalles forecast.

Idaho Power has now rolled out their FUSE program with a Riverware physically based rainfall/runoff model. John mentioned that this new system has helped them get better handle on operations. IPCo has struggled with the same short term/long term issue as the NWRFC described earlier. IPCo is running FUSE in parallel with RFS but next year will be solely on the FUSE system.

Mica, Arrow and Duncan - BC Hydro

BC Hydro was not present at the meeting and did not give a presentation. Erik Pytlak did offer that BC Hydro had some problems with their statistical water supply forecasts which were double-counting snow in the June 1 statistical forecast. BC Hydro petitioned through the Hydromet Committee for a deviation and it was granted. Once again, statistical water supply has some short comings. This is the 3rd time a deviation request has been requested for a statistical forecast. On the other hand, the ESP forecasts have been pretty good. Erik sees that the statistical forecasts will continue to be an issue. Gus mentioned one thing that can be done is to limit calibration to more recent years. Kevin asked if BC hydro manages based on regression-based forecast as opposed to ESP. Erik said that they do not but the statistical forecasts are coupled with the Treaty. BC Hydro manages based on ESP. As a side, Gus asked about work on the Treaty. Erik said that the first session was held in May in D.C. and now formal negotiations have begun and are being handled by the U.S. State Department.

Kyle Dittmer – Salmon Sampler

Paul Wagner was scheduled to present but was not in attendance. Kyle spoke on his behalf. Kyle described the extremeness of this year was strange for a weak La Niña/ENSO neutral year. For a while it was uncertain if storms would arrive. Fish passage was good during May because of high flow in the river. Main concern now is water availability during the summer time. NOAA's long-term guidance shows warmer and drier across the Northwest, so August and beyond will be potentially tough for fish survival. Erik added that weak La Niña's are the hardest to predict. It could be anywhere from very dry to very wet. Weak La Niña's are MJO dominated, so you typically end up with fluctuating conditions from really warm, really cold, really wet, really dry in 45-60 day cycles. This is not easy to predict. Erik also mentioned that Hurricane Bud is starting the monsoon season sooner than normal. Kyle asked if this a sign that climate is changing. Erik said that you can't blame one year on climate change.

Erik brought up coordination of the Corp's Initial Control Flow (ICF) for the Columbia River. This was a challenging year for ICF because flows were ramping up so quickly (unregulated flows jumped from 200 kcfs to 600 kcfs in a matter of a couple days). The ICF was declared May 6 but BPA was seeing that the ICF should have been declared at the end of April. The response BPA got from Corps at the time was that the ICF is based on a 5-day average. Erik asked if this is a new process? The issue is that this could under certain circumstances allow too much water to go

down the system before refill is triggered by the ICF. Jason said that the Corps is looking for persistence in the unregulated flow forecast rather than just a quick spike in flow that drops back down quickly that presents a false positive that the ICF should be triggered. Jason did not know of an explicit 5-day requirement. Erik noted that triggering system refill is tricky as conditions are quickly changing. A potential discussion point for the future is to discuss ICF. Erik's question is what is persistence: 5 days? 8 days? 2 days? In a big year like this maybe it doesn't matter but in a low year it could impact things. Jason will look further into the low water year scenario. He thinks that at 80 MAF a fixed ICF date of May 5 exists for refill.

Erik Pytlak - RMJOC-II Climate Change Study Update

Erik gave an update on the RMJOC-II Climate Change Study. Part 1 of the report is nearing completion. A draft was released on April 30 and had a deadline of May 23 for comments. Erik thinks the final report for Part 1 will be finalized tomorrow (June 15) and will go out on BPA's website Monday (June 18). Three agencies were very helpful in providing comments: CRITFC, NW Power and Conservation Council, and IPCo.

Part 2 is the Hydro-regulation section and that step is underway. Nineteen scenarios will be analyzed and run through hydro-regulation model. The conversion from unregulated to modified flow like flows is done. The next step is to produce water supply forecasts that go into modeling which Jeremy Giovando is working on. Several of those water supply forecasts are complete.

Erik discussed schedule and the fact that the same people that are doing modeling for the RMJOC process are also doing the modeling for CRSO and Treaty, so RMJOC is #3 on the priority list. That could cause delays. Right now, Erik is guessing the 19 scenarios will be completed in early 2019, however, they will have preliminary results from six of the scenarios being completed for CRSO. Erik noted that they want to start hydro-regulation modeling to see what might break before scheduling the next RMJOC-2 workshop.

Jeremy Giovando - RMJOC II Forecasting Approach

The focus has been developing water supply forecasts for the RMJOC climate change study. They are transitioning now to a point that they can show real data that is being produced. To develop the forecasts, they decided to use precipitation and snow water equivalent (SWE) because that data is easy to extract and use and should be highly correlated with streamflow. The key difference between precipitation and SWE is that the same precipitation applies to a group of models whereas snow is unique for each dataset (because of temperature). This data was processed by mapping watersheds above each location and developing basin averages. They also tried a second method of taking individual cells to represent a SNOTEL site but this did not seem to work any better than just taking the average over the watershed. Erik noted that one of the great things about this is that this concept of using a gridded average could conceivably be a new and different way of creating a statistical water supply forecasts and might have a broader application. Gus said that NRCS is already looking at doing something similar with iSNOBAL and the work that the USDA-ARS is doing. Gus mentioned that the State of Colorado has created a way to ingest SNODAS and make a linear regression model. Gus would like to take that one step further and correlate that product to streamflow volumes with regression. One of the tricky parts is that SNODAS uses SNOTEL data to data assimilate. The idea would be to compare results to existing models and see which is better. As an aside, Omaha district is looking at a couple of the watersheds in Wyoming to use VEERS data to estimate spatial distribution and estimate SWE off of that and use it for real-time operations.

Jeremy then discussed the forecast methodology. The forecasts use a principle components regression using both basin average SWE and cumulative precipitation. This is a similar method as the current water supply forecasts for Libby and Dworshak. Jeremy then showed the results

data. One key takeaway is that the variability starts to increase in the future as April 1 SWE begins to decrease with warmer temperatures.

Jeremy's group is now starting to run through scenarios. For the most part they feel like they can move forward and hopefully from now on out this will be production and feeding into hydro-regulation effort.

The group followed the presentation with discussion. Kyle mentioned that this process is light years ahead from RMJOC-I. Jeremy says they have a lot of data if people are interested in seeing it. Bob Heinith asked to get the presentation and Jeremy will forward it on.

Adjournment:

The next CRFG meeting will be scheduled, TBD, by Jason Ward and sent out to the CRFG to likely coincide with other TMT or RMJOC meetings to accommodate traveling schedules. The meeting was then adjourned.

Attendance:

In person

- Jason Ward – USACE-Division
- Geoffrey Walters – NWRFC
- Ryan Lucas – NWRFC
- Amy Burke – NWRFC
- Kevin Berghoff – NWRFC
- Stephen Hall – USACE- Walla Walla
- Kyle Dittmer – CRITFC
- Peter Cooper – U.S. Bureau of Reclamation
- Gus Goodbody – NRCS
- Leslie Bach – NW Power and Conservation Council
- Bob Heinith – CRITFC contractor
- Laura Gephart – CRITFC
- Dianne Barton - CRITFC
- Erik Pytlak – BPA

On phone

- Michael Warner – USACE-Seattle
- John Hildreth – IPCo
- Jeremy Giovando – USACE- Cold Regions Research and Engineering Laboratory

Note Taker: Peter Cooper, CRFG Vice-Chair, U.S. Bureau of Reclamation, Boise, Idaho

September 26, 2018

Meeting time: 8:30 am – 12:00 pm PDT

Location: **Columbia Intertribal Fish Commission (CRITFC), Columbia Room (12th Floor)**

700 NE Multnomah Street, Portland

Telecon Info: USA Toll-Free: (877)873-8018 (also the web meeting number)

ACCESS CODE: 3919765

Security Code, if needed: 1234

Web Meeting: <https://usace.webex.com/join/logan.j.osgood-zimmerman>

Contact Info: Mike Warner (206-764-3278)

Peter Cooper (208-378-5037)

8:30 am **Welcome and Introductions** (Mike Warner)

8:40 **Approval of June Minutes** (all)

8:45 **2018 Water Year to date (~ 10 minutes each for Fall meeting)**

NWS-NWRFC: Kevin Berghoff (or alternate) (systemwide)

NRCS: Gus Goodbody (systemwide)

USACE: Mike Warner (LIB)

Steve Hall (DWR)

Reclamation: Peter Cooper (HGH, upper Snake)

10:00-10:15 << **BREAK** >>

10:15 Idaho Power: John Hildreth

BC Hydro: Georg Jost

10:30 **Status of NRCS staffing and resourcing** (Gus Goodbody)

10:45 **Bureau of Reclamation Forecast Update Status** (Peter Cooper)

11:00 **“The Sampler” Salmon Manager Topics? Forecast Updates?** (Paul Wagner),
Misc

11:15 **RMJOC-II Climate Change Study Update** (Erik Pytlak)

11:30 **RMJOC II Forecasting Update** (Jeremy Giovando)

12:00pm **Set next Meeting and Adjourn**

Meeting Minutes

**Columbia River Forecast Group (CRFG) – Fall 2018 Meeting: September 26, 2018
Columbia River Inter Tribal Fish Commission (CRITFC), Columbia Room (12th Floor)
700 NE Multnomah Street – Suite 1200, Portland, Oregon**

Introductions:

Mike Warner (Corps of Engineers) introduced himself and was designated as the new CRFG Chairman as previous chairman Jason Ward has taken another job. Chairman Warner opened the meeting at 8:30 am. The attendees introduced themselves.

Approval of Minutes:

Chairman Warner asked the members to approve the meeting minutes from the June 2018 Summer CRFG Meeting. It was so moved by Erik Pytlak and was seconded by Kyle Dittmer and they were approved as final.

2018 Water Year to Date Summaries:

Systemwide – Kevin Berghoff, NWS-NWRFC

Kevin began by describing water year (WY) 2018 precipitation. October to April in the Upper Columbia saw above to well above normal precipitation, however, precipitation dropped off dramatically after April. The same pattern was seen in the Snake basin. Overall it was a very dry summer. For temperature, January and May were very warm in 2018. The warm temperatures in May caused rapid snowmelt runoff. Kevin then showed snowpack from April 2018. The snowpack in 2018 was much larger than 2017 in the Upper Columbia but was much smaller than in 2017 in the Snake. Locations in the northern and eastern portions of the basin had strong snowpack, while those in the southern and western portions of the basin were deficient. Runoff conditions were very strong in May with the warm temperatures but then dropped off fairly quickly with the lack of precipitation in the summer. Kevin showed the NWRFC climatic index vs. runoff tool and noted this is the time of year to look at that tool since little other information is available.

Levi asked why was runoff above normal but precipitation was below normal? Levi hypothesized perhaps it was the efficient capture of runoff in May? Kevin notes that higher elevations got more precipitation than lower elevations and cold temps allowed good buildup of snowpack. Kevin agreed it was a very efficient runoff in May. Kevin also thinks 2017 was a wet year and primed the soils. Pete added this was seen in the Boise basin this year where snow had essentially melted out but high runoff remained longer than would have been expected.

Paul asked why is this the time of year to look at the climatic indicators? Kevin stated that there is not much else to go on right now. Mike added that climatic indicators are a fairly good predictor this time of year.

Systemwide – Gus Goodbody, NRCS:

Gus described that record snowpack was seen along the Continental Divide in Montana this year. This resulted in a lot of flooding on the Clark Fork River in May. Gus also noted that this year saw the largest May runoff for the Columbia River at The Dalles in the 80+ year period of record. The big story was high early runoff followed by a below normal runoff for the rest of summer.

On the administrative side, NRCS has shifted forecasters around and they are planning to continue making forecasts this season. Gus is taking over the Pend Oreille and Kootenai area and Chris Brown will be running the Snake and lower and middle Columbia forecasts. Gus has been busy recalibrating the Upper Columbia, Pend Oreille and Kootenai basins this summer. He noted that

he has learned in that process that the previous water year effect is highly variable but adding in an antecedent runoff component to the forecast increased skill quite a bit.

Pete asked how NRCS handles burned or logged SNOTEL sites. Gus said generally they do not use a site that has been disturbed like that. This began a long conversation regarding how to handle SNOTEL sites that have been disturbed. The group discussed how the radiative properties, precipitation capture, melt rates, and aerodynamic profile all have significant changes after a fire. This causes discontinuity in the data record that is hard to deal with. The group also discussed clear cutting and how relationships are key to ensuring preventable human caused disturbances do not occur. Gus mentioned he is in the process of trying to determine which sites have been disturbed. After much discussion, the group agreed that this should be a topic the group should continue to grapple with in the future.

Libby – Mike Warner, USACE

Mike presented on operations at Libby Dam. Overall, Libby basin saw slightly below normal precipitation for the water year, but early in the season precipitation was well above normal. May saw a very efficient runoff and the runoff went from well above normal to below normal quickly. The basin has seen a warm and dry summer. The April and May forecasts ended up being around 1-MAF higher than observed. Mike echoed the statements about burned SNOTEL sites and noted that Akamima Pass, one of the SNOTEL sites used in their forecasts, burned in 2017. For 2018, they used a regression technique to estimate snowpack at Akamima Pass from surrounding stations. That's what they will do this year as well until they can get the forecast procedure updated. Mike noted that they are currently working on developing a new forecast for use in 2020.

Paul asked if precipitation had been average, would actual runoff have been closer to the forecast? Mike said the difference between the forecast and actual was combination of temperature and precipitation. Dry conditions were impactful. The beginning of April forecast was high based on a large snowpack but then the precipitation turned off. If it would have kept raining, the actual runoff probably would have been closer to forecast. If you get precipitation during the runoff, then it runs off more efficiently.

Dworshak – Steve Hall, USACE

Steve showed the evolution of the Dworshak forecast throughout the year. The forecast was fairly normal up to February and then ramped up. The April 1 forecast was 3.1-MAF which caused a subsequent significant decrease in FRM (Flood Risk Management) elevation. The May forecast backed off a little bit at 3-MAF and that is pretty much where it held for the remainder of the season. Ended up having a slightly smaller runoff than forecast. Steve noted that the Corps' forecasts were in really tight agreement throughout the year around 3-MAF.

Paul asked whether the November forecast is mainly driven by ENSO? Steve replied that yes, September SOI along with precipitation at headquarters, is what informs the early season forecasts.

Hungry Horse and Upper Snake – Peter Cooper, Reclamation

Peter presented on Hungry Horse first. Peter showed a plot of SWE at Noisy Basin SNOTEL site for the 1981-2018 period and noted that 2018 was much higher than most other years except for 1997 and 2011. Hungry Horse had the highest inflows on record (1927-2018) for the month of May and had the 5th highest April-July runoff on record. The forecast continued to increase throughout the winter as the snowpack increased. With the large runoff in May, the June forecast did not perform very well.

Paul asked why the June Hungry Horse forecast did not perform well. Peter thought it was because of the large runoff in May.

Peter then showed the Upper Snake. Peter showed a low, mid, and high elevation SNOTEL site and noted that early in the year the low elevations snowpack was minimal. However cool temperatures into April allowed the snowpack to build to near or above normal levels. Heise unregulated flow was the 8th highest on record (1911-2018) for the month of April, the 3rd highest for the month of May, and April to July, Heise unregulated volume was the 19th highest. The adopted forecast stayed fairly steady throughout the winter but was lower than observed. Part of the reason why the forecast was lower was because of a large 3-4" rain event in June that added significant volume to the runoff.

Brownlee - John Hildreth, Idaho Power Company (IPCo)

John discussed that high flows from WY 2017 increased spring flows above Brownlee. He watches the USGS Box Canyon Springs site as an indicator of the flows. John discussed the spring operations at Brownlee. John also talked about how managed ground water recharge is becoming a larger wild card in their forecast. More than 1-MAF of managed recharge has occurred during the 2017 and 2018 seasons in the Upper Snake River above Milner.

Paul asked if recharge is coordinated with Reclamation. Pete answered that yes, it is. Kevin asked where it occurs. John said all of the recharge occurs upstream of Milner and it returns at Thousand Springs near Hagerman, Idaho and also in the Blackfoot reach of the Upper Snake River. Erik asked if recharge will be included in the upcoming 2020 modified flows. Joel answered that he was unsure and would have to find out more information.

John talked about IPCo's new FEWS system coupled with Riverware. This is a physically-based modeling system used to generate natural flows which are then run through a Riverware regulation model. Potentially IPCo could give a presentation on its operation to CRFG in the future.

John also mentioned that IPCo has a new website that includes a more graphical user interface. The site has data for all of the gauges that IPCo maintains.

Mica, Arrow and Duncan - BC Hydro

BC Hydro was not present at the meeting and did not give a presentation.

Gus Goodbody – Status of NRCS staffing and resources

At the June CRFG meeting, the group discussed submitting a letter of support for NRCS. An inquiry was sent by Jason Ward (CRFG Chairman at the time) to the NRCS Water and Climate Center director and a response was given at that time that they are going to be able to start to fill positions and a formal letter may not be necessary. In follow up, Gus has since been told that a letter of support from CRFG to Director Mike Strobel would be welcomed. Steve Hall and Peter Cooper volunteered to draft the letter which will include support for both regional and local offices and will send out to the group for review before submittal.

Gus is cautiously optimistic they will get some positions filled in the forecasting group. Gus mentioned that the state offices are under a different management structure and may not be as lucky. Four to five hydrologist positions are potentially opening up in the hydrology section. In the meantime, Gus is short two forecasters in the group. Right now, Gus sees no immediate impact to the forecasts for this year, however, they may only issue forecasts in the February to May time period (not January or June) due to limited staff. Daily forecasts are running, but no effort is going into those to update or recalibrate. It is a pretty tenuous system and could disappear.

Rick mentioned that he noticed the SNOTEL network went down regularly this year and asked if there is any effort to stabilize that system? Gus said that as problems come up they try and handle them.

Peter Cooper – Bureau of Reclamation Forecast Update Status

Peter described that the PN Region of Reclamation provides forecasts for 34 locations in the region starting in January and continuing throughout the spring. The current methods include a multiple linear regression (MLR) and a Principle Component Regression (PCR). These have been well known and effective in reservoir operations, however, they are interested in investigating the possibility of improving the forecast methods. This process will provide another tool in the tool box and may not completely replace the existing methods.

The updated procedures will 1) reflect the hydrology in each basin, 2) provide a reproducible process, 3) use readily available data, 4) potentially use additional indicators such as climatic indices, 5) provide the ability to adapt in real time, and 6) document procedures.

Peter described that the process will likely take 2 to 4 years and will be a collaborative effort with the Great Plains (GP) Region of Reclamation. The GP Region is in the process of developing “PyCast” which so far appears to be a very powerful forecast creation tool.

This will be a six-phase process: 1&2 (current phase) – tool development and data gathering, 3) forecast study of five locations (i.e., Snake at Heise, Boise, Owyhee, Yakima, Hungry Horse), 4&5) development of all 34 locations and implementation, and 6) outreach. Peter will continue to update the CRFG as the process progresses.

Paul Wagner – “The Sample” Salmon Manager Topics

Paul told the group to continue the mission to improve forecasts. A few notes Paul had were that the Libby forecast caused the operations to try and catch up. Paul discussed the work that NOAA research scientist Sarah Kapnick is doing to create a new tool to forecast mountain snowpack months in advance. He noted that the forecast did not perform well in the Sierras but did show promise elsewhere.

Ken Nowak noted that the Western States Watershed Council has been active in trying to promote advancement of seasonal weather forecasts and mentioned that at Reclamation, there has been an effort to try and advance that forefront with a year long forecasting prize competition. The benchmark is to try and beat the NOAA weeks 3-5 forecast. Teams did beat NOAA. Reclamation is in the process of determining the winners. The leaderboard is hosted by drought.gov and can be found by googling “forecast rodeo.” Ken then demonstrated the drought rodeo website.

Kyle asked whether target flows will be incorporated in the new BiOp? Paul responded that target/objective flows are incorporated with the objective to try and keep reservoirs full as possible in spring.

Erik Pytlak – RMJOC II – Climate Change Study Update

Erik stated that there is not much to report. The RMJOC II report did get published in June and is getting a lot of hits. Erik mentioned that the same people that are doing RMJOC II modeling are also doing Columbia River Treaty and CRSO project work -which take precedence. RMJOC II work has slowed because of that. Progress is still going on as time allows from staff that are involved. Flows have to get converted from NRNI back to modified-flow like. They are not looking at a fall workshop right now.

Jeremy Giovando – RMJOC II Forecasting Update

Jeremy described that the method was to take a SWE and precipitation grid within a mapped basin above each forecast point. Those became the primary inputs into the forecast development. Jeremy focused on three locations: Dworshak, Libby, and The Dalles. Jeremy showed the overarching view of the training error results. In general, error decreases from January through June, and a few modeling combinations perform better than others.

Next Jeremy showed exceedance plots of observed vs. forecast to see what types of events are being forecasted.

Future work will be to continue to post process and analyze the results, process forecasts for all hydrology datasets, development, and evaluation of transient forecasting.

Bob asked if Jeremy could give a time schedule for this process of moving forward with processing all the datasets. Jeremy said that right now they almost have all of the RCP 8.5 scenarios processed. For the RCP 4.5 scenarios or any other datasets they are currently working out that schedule now and he did not have an answer yet.

Adjournment:

The next CRFG meeting will be scheduled, TBD, by Mike Warner and sent out to the CRFG to likely coincide with other TMT or RMJOC meetings to accommodate traveling schedules. At this time, December 6 appeared to be a potential date. The meeting was then adjourned.

Attendance:

In person

- Mike Warner – USACE-Seattle
- Stephen Hall – USACE- Walla Walla
- Alfredo Rodriguez – USACE – Walla Walla
- Sarah Delevan – USACE -NWD
- Kyle Dittmer – CRITFC
- Bob Heinith – CRITFC contractor
- Kevin Berghoff – NWRFC
- Peter Cooper – USBR
- Joel Fenolio – USBR
- Jon Rocha – USBR
- Levi Brekke – USBR
- Ken Nowak – USBR
- Gus Goodbody – NRCS
- Erik Pytlak – BPA
- Rick Vanderzweep – BPA
- Paul Wagner – NOAA Fisheries
- Kresta Davis-Butts – IPCo
- John Hildreth – IPCo
- Frank Gariglio – IPCo

On phone

- Logan Osgood-Zimmerman – USACE-Seattle
- Jeremy Giovando – USACE- Cold Regions Research and Engineering Laboratory

Note Taker: Peter Cooper, CRFG Vice-Chairman, U.S. Bureau of Reclamation, Boise, Idaho

December 6th, 2018

Meeting time: 8:30 am – 1:45 pm PST

Location: National Oceanic and Atmospheric Administration (NOAA) - Fisheries
Mt. St. Helens Room
1201 NE Lloyd Blvd, 10th Floor
Portland, OR 97232

Attendees must first sign in with the receptionist on the 11th Floor!

Telecon Info: USA Toll-Free: (877)873-8018 (also the web meeting number)
ACCESS CODE: 3919765
Security Code, if needed: 1234

Web Meeting: <https://usace.webex.com/join/logan.j.osgood-zimmerman>

Contact Info: Mike Warner (206-764-3278)
Peter Cooper (208-378-5037)

8:30-8:40a **Welcome and Introductions** (Mike Warner)

8:40-8:45 **Approval of October Minutes** (all)

8:45-9:15 **2018 Water Year**
CRITFC: Kyle Dittmer (TDA)
IPCo John Hildreth (2018/19)
Discussion about 2018 and lessons learned

9:15-10:15 **Water Year 2019 (~ 15 minutes each)**
NWS-NWRFC: Kevin Berghoff (systemwide)
NRCS: Gus Goodbody (systemwide)
BC Hydro: Georg Yost, BC
CRITFC: Kyle Dittmer (TDA)

10:15-10:30 << **BREAK** >>

10:30-11:15 **Water Year 2019, continued**
Reclamation: Peter Cooper (HGH, upper Snake)
USACE: Steve Hall (DWR)
Mike Warner (LIB)

11:15-11:45 **The Sampler** (Salmon manager odds-and-ends, other items to note for WY 2019)

11:45-12:15p << **LUNCH** >>

12:15-1:15 **Additional Topics of Discussion**
New plans, new products/services/procedures?
NRCS Letter of Support
Funding sources for hydrology publications
Presidential Memo released 19 October 2018

New 2018 National Climate Assessment – initial review and thoughts?
Further discussion of wildfire-impacted SNOTEL sites

1:15-1:45 **Transition leadership (Peter Cooper to Chairman, Kyle Dittmer to Vice-Chairman)**

Goals for 2019

Special Recognition

Set next meeting

Meeting Minutes

**Columbia River Forecast Group (CRFG) – Autumn 2018 Meeting: December 6th, 2018
National Oceanic and Atmospheric Administration (NOAA) Fisheries – Mt. St. Helens Room
1201 NE Lloyd Blvd, 10th Floor, Portland, Oregon**

Introductions:

Chairman Mike Warner opened the meeting at 8:45 am. The attendees introduced themselves.

Approval of Minutes:

Chairman Warner asked the members to approve the meeting minutes from the September 2018 Fall CRFG Meeting. It was so moved by Paul Wagner and was seconded by Kyle Dittmer and they were approved as final.

2018 Water Year Summaries:

Systemwide – Kyle Dittmer, Columbia River Inter-Tribal Fish Commission (CRITFC)

Kyle Dittmer provided a recap of the performance of his MEI forecast for water year (WY) 2018. Kyle was happy with the performance. Overall (2008-2018) the MEI method at The Dalles was 9 percent low for the January through July timeframe, 9 percent low for the April through July timeframe, and 7 percent low for the April through August timeframe. Kyle has also developed a similar method using the ONI index and showed those results. Overall the ONI method at The Dalles was 8 percent low for the January through July timeframe, 9 percent low for the April through July timeframe, and 6 percent low for the April through August timeframe. The ONI appeared to do slightly better in the early part of the season. Kyle plans to further develop the ONI method in the coming months.

Brownlee - John Hildreth, Idaho Power Company (IPCo)

John Hildreth provided a recap of IPCo's operations during WY2018. John highlighted the deep draft that was required at Brownlee Reservoir during the spring for system flood control. The runoff forecast at the Columbia River at The Dalles was the driving force behind the deep draft even though runoff forecasts above Brownlee were not significant - a unique trait for this year. John showed IPCo's internal forecast that came in slightly low in February but increased to match actual as the spring progressed. John highlighted some forecasting challenges including: Accounting for managed recharge, determining when to allow the model to run vs. manual regulation, and capturing changing groundwater conditions. John then provided a description of Idaho Power's runoff forecasting method which he described as being similar to the system that the Northwest River Forecast Center (NWRFC) uses. The model ingests current basin states, short-term weather forecasts, and any known upstream reservoir operation. The model then uses three different future climatic conditions (base case: median, low case: 70 percent of median, and high case: 140 percent of median) to produce a range of anticipated inflow volumes and shapes. This data is then processed through the FEWS system and is fed to a Riverware operational model to help guide operational decisions. Idaho Power forecasts 130 different forecast points within the Snake River and Salmon River. Erik Pytlak asked a question about the future precipitation that the model ingests. John described that IPCo lumps future precipitation into two events per month to provide for a more realistic soil moisture condition. John described a number of future development efforts, including: Adding weather forecast processes directly into FEWS, continuing to improve Riverware operational models, investigating neural networks, and basin recalibration.

WY2018 Lessons Learned:

The major lesson learned during WY2018, which seems to have become more of the normal than an anomaly, is the warm spring time temperatures, particularly in May, which resulted in the

snowpack ripening up early and the runoff coming off early. This continues to be a theme discussed by the group.

2019 Water Year Preview:

Systemwide – Ryan Lucas and Kevin Berghoff, NWS-NWRFC

Ryan began by reviewing basin conditions in WY2018. The main story was wet conditions in the north and east and dry conditions in the south and west. Temperatures warmed up in May and stayed warm throughout the remainder of the spring and summer. Erik reminded the group that warm overnight lows in May ramped up runoff into high gear, earlier than normal. Ryan showed the ONI vs. runoff trend, and WY2018 followed the trend with higher than normal runoff at Libby, Hungry Horse, Dworshak, and The Dalles for the April through September time period. A review of the daily ESP forecasts was shown for those four locations as well. All showed near normal median forecasts until February when wet spring conditions increased runoff volume in the basins. The warm temperatures in May resulted in a much above normal runoff in May, followed by below normal runoff for the remainder of the summer at The Dalles. Ryan then transitioned into a preview of WY2019 by showing the CPC forecast of El Nino conditions likely though the winter. The trend isn't clear and there is still a lot of winter to go.

Kevin then provided an update to the discussions that NWRFC, Reclamation, Corps, and IPCo had back in September regarding improving the Snake River at Milner forecast. Kevin described modification to the Milner forecast they made back in 2017, which has greatly improved the forecast. There does appear to be potential for future enhancements which may also provide some improvement. These enhancements include updating canal flow data, adjusting for flow augmentation, IPCo storage releases, and groundwater recharge, and continued coordination with Reclamation. Kevin will continue to keep the group abreast as discussions continue.

Systemwide – NRCS

NRCS did not give a presentation.

Mica, Arrow and Duncan - BC Hydro

BC Hydro was not present at the meeting and did not give a presentation.

Systemwide – Kyle Dittmer, Columbia River Inter-Tribal Fish Commission (CRITFC)

Kyle presented on the performance of his 2017-2018 winter climate forecast for Portland and Government Camp. Kyle's prediction of near normal temperatures for the November through March time frame mostly verified, however, January turned out to be quite a bit warmer than Kyle had predicted. Kyle had predicted near normal precipitation, for the same period, but overall the actual precipitation was near 80 to 85 percent of normal. Kyle's snow event prediction for Portland verified fairly well. The MEI method resulted in a January through July forecast error of ± 5 to 7 percent.

Kyle then described his MEI forecast method. Kyle showed results from the November run of his MEI and ONI forecast methods. The MEI and ONI methods are both forecasting a runoff of 99 MAF (98% of normal) for the January through July time period.

Kyle also provided his climate forecast for the 2018-2019 winter. Kyle is predicting near normal temperatures and precipitation, with a larger than normal snowpack (117%) at Government Camp. In Portland, Kyle is predicting near normal temperatures, slightly below normal precipitation, and three snow events (DEC-FEB).

Hungry Horse and Upper Snake – Peter Cooper, Reclamation

Peter showed a preview of the conditions we may be facing in WY2019 by comparing years with similar ONI conditions to the runoff in those years. The current forecast is for the OND time period of the ONI index to have a value of between 0.5 and 1.5. Historically, this condition has resulted in below normal runoff conditions in both the Snake at Heise and Hungry Horse basins. Typically, during years with these conditions, the snowpack builds fairly well through January, but then tapers off for the remainder of the season. This causes the January forecast to over-forecast the runoff. By April, the forecasts do a better job of tracking the actual runoff.

Dworshak – Steve Hall, USACE

Steve described the runoff forecast for Dworshak. The Shanghi Summit SNOTEL site is not currently operating. They hope to visit the site in January to get it back up and running. Steve also provided an update on Unit 3 at Dworshak and noted that he is anticipating that Unit 3 will be back operational ahead of the runoff season.

Libby – Mike Warner, USACE

Mike started by showing the evolution of Libby's WY2018 forecast. The forecast dropped below normal in January, then built through the spring with wet conditions, and eventually fell back to near normal. Actual inflow volume was 6.195 MAF for the April through August time frame. The forecast error was +0.994 MAF in April and +1.161 MAF in May. Mike then let the group know that Akamina Pass SNOTEL site burned and is currently being estimated. They are beginning the process to update the forecast for WY2020 to account for this. Mike then showed the December forecast for WY2019 runoff at Libby. The December forecast for the April through August timeframe came in at 5.784 MAF which is near average. The NWRFC median ESP 5-day forecast is currently 5.381 MAF.

The “Sampler” Salmon Manager Topics:

Paul Wagner led the discussion with an eye towards WY2019 operations. Paul is concerned with the dry start to the water year, noting that typically he has heard that El Nino conditions generally start off wet but then dry up later. Many locations have yet to have that wet start. Paul mentioned that the current operation out of Grand Coulee is to maintain a minimum tailwater below Bonneville for the Chum salmon. If dry conditions continue, this will cause quite a deep draft in Grand Coulee which could have an impact on spring operations next season. During this topic the group also looked at soil moisture in the basin and saw that soil moisture conditions in the basin are much drier than they were at this time last year.

Additional Topics of Discussion:

New Plans, New Products/Services/Procedures

Kevin Berghoff started the discussion by noting that NWRFC does not have a lot of new products this year. The main one is that the ESP Natural forecast information can now be displayed on the website. Peter Cooper gave an update on Reclamation's runoff forecast update project. The project is still in its early stages and is currently in the data gathering phase. Reclamation produces runoff forecasts for 34 locations in the region. All 34 forecast locations will be updated in the next few years. They will start by focusing on five locations: Heise, Boise, Owyhee, Yakima, and Hungry Horse. The goal will be to have updated runoff forecast methods ready to run in parallel with the existing methods by the start of WY2020 for those 5 locations. Peter will continue to provide updates to the group. Erik Pytlak gave a Columbia River Treaty Hydromet Committee update to the group and noted that December forecasts are now being used for operational decision making. This does not affect Libby since a December forecast was already being used. The Committee is also beginning to talk seriously about looking into the use of ESP forecasts rather than statistical methods for Libby and Hungry Horse.

NRCS Letter of Support

Peter and Steve drafted a letter of support that was then sent around for review to the larger CRFG group. Mike received a number of comments back. The letter has not been formally sent. Cara McCarthy with NRCS provided the group with an update. The main takeaway was that the group should continue down the path of sending the letter, and additional help from other interested parties, such as the irrigation community, may be needed. This continues to be a staffing issue and not a budget issue. Mike will incorporate the comments into the draft letter and will send to the core CRFG group for review. The goal will be to send the CRFG letter out in the next few weeks.

Funding Sources for Hydrology Publications

Kyle informed the group that he is wanting to pursue publishing a paper on his MEI forecasting method. Unfortunately, the cost of publishing has skyrocketed and from what he has seen, the base cost is \$2,000 with an additional \$5,000 for “open access” for users. Unfortunately, the group has not found money within their respective organizations that could help defray these costs. However, the group did offer the suggestion that there may be cheaper alternatives, such as online journals or the Hydrology and Earth System Sciences journal. Kyle will continue to investigate with the hopes of publishing in the next 12 to 18 months.

Other Topics

Due to time constraints, the group decided to push the discussion related to the Presidential Memo, the new 2018 National Climate Assessment, and the discussion related to wildfire impacted SNOTEL sites to the next meeting.

Transition Leadership and Goals for 2019:

The chairmanship was transitioned to Peter Cooper for 2019. Kyle Dittmer will serve as vice-chairman. The group thanked Mike for stepping in for Jason Ward and commended Mike on doing a great job chairing the group this year.

Special Recognition:

Paul Wagner will be on “phased” retirement at the end of the year. His replacement at NOAA-Fisheries should be onboard soon. Kyle presented Paul with a card to recognize his achievement and to thank him for his service. Paul has been a wonderful contributor to the CRFG group and will be missed in the future.

Adjournment:

The next CRFG meeting will be scheduled, TBD, by Peter Cooper and the date will be sent out to the CRFG membership. It will likely be scheduled to coincide with other TMT or RMJOC meetings to accommodate traveling schedules. At this time, a meeting in February was tentatively planned. The meeting was then adjourned at 1:45 pm.

Attendance:

In person

Mike Warner – USACE-Seattle
Logan Osgood-Zimmerman – USACE-Seattle
Sarah Delevan – USACE -NWD
Kyle Dittmer – CRITFC
Kevin Berghoff – NWRFC
Ryan Lucas – NWRFC
Peter Cooper – USBR
Cara McCarthy – USDA-NRCS
Paul Wagner – NOAA Fisheries

John Hildreth – IPCo
Leslie Bach – NPCC

On phone

Stephen Hall – USACE- Walla Walla

Jeremy Dalling – USBR

Erik Pytlak – BPA

Note Taker: Peter Cooper, CRFG Vice-Chairman, U.S. Bureau of Reclamation, Boise, Idaho

Appendix C

Historical forecast results

Columbia River Forecast Group 2018

Historic forecast results: http://www.nwd-wc.usace.army.mil/report/flood_risk

Historical Jan-Jul Results for The Dalles and Lower Granite and Observed KAF:

<http://www.nwrfc.noaa.gov/ws>

1. Use the interactive map at the web address above.
2. Go to the forecasting map for TDA and LWG or the runoff map for Observed results.
3. Click on the dam needed and for TDA and LWG, look up the appropriate archive data. For the observed runoff, click on the dam needed and add up the observed for the months stated in the tables below.
4. In 2012, the official Water Supply Forecasts used for FCRPS operations for Grand Coulee, Brownlee, Lower Granite, and The Dalles changed to the NWRFC ESP median issued on certain days of the month, and based on different lead times on future precipitation:

2012: 4th working day of the month, 10 days of future precipitation

2013: 5th working day of the month, 3 days of future precipitation

2015: 5th working day of the month, 5 days of future precipitation

2016: 5th working day of the month, 5 days of future precipitation

2017: 3rd working day of the month, 5 days of future precipitation

2018: 3rd working day of the month, 5 days of future precipitation

Duncan: (Apr-Aug)											
Year	Jan		Feb		Mar		Apr		May		Observed
	KAF	% of OBS	KAF	% of OBS	KAF	% of OBS	KAF	% of OBS	KAF	% of OBS	KAF
2005	2003	109%	2013	110%	1972	108%	1968	107%	1876	102%	1834
2006	1839	87%	1906	90%	1946	92%	1922	91%	1932	91%	2120
2007	2087	88%	2122	90%	2096	88%	2221	94%	2257	95%	2370
2008	2202	113%	2091	107%	2091	107%	2059	105%	1985	101%	1957
2009	2003	123%	1945	120%	1866	115%	1859	114%	1787	110%	1627
2010	2030	125%	1962	121%	1825	113%	1817	112%	1813	112%	1621
2011	1846	82%	1942	86%	1912	85%	1997	89%	2057	91%	2251
2012	1987	77%	2039	79%	2015	78%	2138	83%	2227	87%	2571
2013	2283	105%	2079	96%	1975	91%	2061	95%	2094	96%	2172
2014	1785	86%	1728	83%	1761	85%	1891	91%	1903	91%	2081
2015	2148	122%	2061	117%	1995	113%	1958	111%	1912	108%	1766
2016	2063	106%	1978	101%	1961	101%	1972	101%	2063	106%	1951
2017	2010	91%	1954	89%	1942	88%	2036	93%	2103	96%	2198
2018	1995	96%	2061	99%	2174	105%	2208	106%	2167	104%	2079

Libby: (Apr-Aug)											
Year	Jan		Feb		Mar		Apr		May		Observed
	KAF	% of OBS	KAF	% of OBS	KAF	% of OBS	KAF	% of OBS	KAF	% of OBS	KAF
2005	5786	104%	5630	101%	5371	97%	5401	97%	5096	92%	5564
2006	5487	83%	6186	93%	6350	96%	6076	92%	6179	93%	6629
2007	6955	102%	6582	96%	6516	96%	6847	100%	6990	102%	6822
2008	6282	113%	6498	117%	6435	116%	6387	115%	6166	111%	5539
2009	5526	125%	5436	123%	5296	120%	5672	128%	5209	118%	4425
2010	5682	126%	5478	121%	5084	113%	5103	113%	4887	108%	4517
2011	5610	73%	6656	86%	7111	92%	7191	93%	8165	106%	7729
2012	5524	69%	5714	62%	5635	61%	6872	75%	7159	78%	9185
2013	6898	96%	6384	89%	6315	88%	6189	86%	6535	91%	7173
2014	5432	81%	5192	78%	5505	82%	6868	103%	6996	105%	6673
2015	6297	148%	5523	130%	5683	134%	5808	137%	4826	114%	4250
2016	6249	115%	6318	117%	6472	120%	6681	123%	5831	108%	5414
2017	6861	98%	5583	80%	6783	97%	7654	109%	8190	117%	7016
2018	6645	107%	6765	109%	7205	116%	7189	116%	7356	119%	6195

Hungry Horse: (May-Sep)											
Year	Jan		Feb		Mar		Apr		May		Observed
	KAF	% of OBS	KAF	% of OBS	KAF	% of OBS	KAF	% of OBS	KAF	% of OBS	KAF
2005	1647	129%	1418	111%	1144	90%	1217	95%	1173	92%	1275
2006	1826	99%	2024	110%	1958	106%	1912	104%	1824	99%	1841
2007	1823	137%	1803	136%	1786	134%	1495	112%	1425	107%	1330
2008	1840	76%	1859	77%	1876	78%	1913	79%	2131	89%	2408
2009	1809	114%	1864	117%	1697	107%	1817	114%	1816	114%	1589
2010	1654	103%	1429	89%	1284	80%	1305	81%	1345	84%	1606
2011	1944	61%	2139	67%	2222	69%	2357	73%	2798	87%	3213
2012	1691	81%	1781	86%	1739	84%	1906	92%	1680	81%	2078
2013	1968	107%	1877	102%	1743	95%	1750	95%	1789	98%	1833
2014	1787	73%	1819	75%	2142	88%	2204	90%	2400	98%	2439
2015	1977	213%	1927	208%	1678	181%	1496	162%	1499	162%	926
2016	1629	135%	1531	127%	1573	131%	1556	129%	1251	104%	1204
2017	1828	101%	1489	82%	1691	93%	1769	97%	2018	111%	1818
2018	1964	77%	2062	80%	2302	90%	2395	93%	2500	98%	2563

Grand Coulee: (Apr-Aug)											
Year	Jan		Feb		Mar		Apr		May		Observed
	KAF	% of OBS	KAF	% of OBS	KAF	% of OBS	KAF	% of OBS	KAF	% of OBS	KAF
2005	54863	112%	53657	110%	45820	94%	47628	98%	47628	98%	48807
2006	55466	91%	58480	96%	57877	95%	57275	94%	58500	96%	61189
2007	60000	105%	61600	107%	61200	107%	61600	107%	61000	106%	57350
2008	59300	99%	59200	99%	61300	103%	61600	103%	60000	100%	59739
2009	55800	116%	54600	113%	53100	110%	55400	115%	54000	112%	48186
2010	54000	113%	49100	103%	45800	96%	44900	94%	45300	95%	47711
2011	56500	75%	61400	82%	62200	83%	64700	86%	70800	94%	75107
2012	44509	56%	56788	71%	60853	76%	68525	86%	72812	91%	79874
2013	58230	89%	54536	84%	54020	83%	55882	86%	57373	88%	65121
2014	54683	87%	48197	77%	57818	92%	60382	96%	64683	103%	62620
2015	56539	134%	55845	133%	49419	117%	51165	121%	45498	108%	42145
2016	52783	102%	54491	105%	56411	109%	57009	110%	56763	110%	51836
2017	54930	84%	53656	82%	57336	87%	64955	99%	68159	104%	65575
2018	55852	85%	64817	98%	65870	100%	68335	104%	71449	108%	66018

Brownlee: (Apr-Jul)											
Year	Jan		Feb		Mar		Apr		May		Observed
	KAF	% of OBS	KAF	% of OBS	KAF	% of OBS	KAF	% of OBS	KAF	% of OBS	KAF
2005	3170	88%	2590	72%	1740	48%	2180	60%	2440	68%	3612
2006	6690	75%	8016	89%	6940	77%	8380	93%	9020	101%	8975
2007	5200	185%	3630	129%	3760	134%	3300	118%	3040	108%	2807
2008	4390	101%	5260	120%	5500	126%	5400	124%	4860	111%	4368
2009	4260	76%	4020	72%	3350	60%	4970	89%	5000	90%	5575
2010	3300	72%	3020	66%	2470	54%	2590	56%	2780	61%	4586
2011	7230	69%	6280	60%	5690	54%	7510	71%	9060	86%	10549
2012	4783	86%	4986	90%	5211	94%	6388	115%	6162	111%	5535
2013	4650	178%	4229	162%	3744	144%	3478	133%	2673	102%	2609
2014	3723	108%	3246	94%	3861	112%	3934	114%	3519	102%	3436
2015	4831	197%	4665	190%	3738	153%	3052	125%	2289	93%	2449
2016	4693	118%	4689	118%	4623	116%	4767	120%	4373	110%	3969
2017	4801	48%	5327	53%	7560	75%	10845	108%	11277	113%	10019
2018	5690	99%	5509	96%	5665	98%	6436	112%	5889	102%	5753

Dworshak: (Apr-Jul)											
Year	Jan		Feb		Mar		Apr		May		Observed
	KAF	% of OBS	KAF	% of OBS	KAF	% of OBS	KAF	% of OBS	KAF	% of OBS	KAF
2005	1914	116%	1642	100%	1423	87%	1321	80%	1344	82%	1643
2006	2601	97%	2707	101%	2612	98%	2593	97%	2626	98%	2677
2007	2905	161%	2126	118%	2192	122%	1982	110%	1868	104%	1799
2008	2717	79%	2738	80%	2810	82%	3010	88%	3003	87%	3434
2009	3075	121%	2681	106%	2461	97%	2662	105%	2631	104%	2539
2010	2174	114%	1742	91%	1571	82%	1398	73%	1526	80%	1906
2011	3340	83%	3142	78%	3329	82%	3387	84%	3772	93%	4042
2012	2473	74%	2504	75%	2585	77%	2966	89%	3226	97%	3343
2013	2587	123%	2202	105%	2128	101%	2036	97%	2296	109%	2105
2014	2296	78%	2274	77%	2701	92%	3111	106%	3183	108%	2943
2015	2136	198%	1922	178%	1815	168%	1709	158%	1325	123%	1081
2016	1913	93%	1986	69%	2025	98%	2308	112%	2090	101%	2068
2017	3055	105%	2541	88%	2867	99%	2984	103%	2941	102%	2896
2018	2941	98%	2849	95%	3093	103%	3040	101%	3032	101%	3001

Lower Granite: (Jan-Jul)											
Year	Jan		Feb		Mar		Apr		May		Observed
	KAF	% of OBS	KAF	% of OBS	KAF	% of OBS	KAF	% of OBS	KAF	% of OBS	KAF
2005	20700	114%	18000	99%	14600	81%	15700	87%	16500	91%	18134
2006	31600	98%	34500	107%	31900	99%	33200	103%	34900	108%	32194
2007	28200	149%	23000	122%	23500	124%	21400	113%	20600	109%	18887
2008	27200	99%	29500	107%	29200	106%	28000	102%	26500	96%	27522
2009	25700	89%	25100	87%	22400	78%	26400	91%	26900	93%	28899
2010	22400	100%	19300	86%	17000	76%	16600	74%	17000	76%	22460
2011	31253	75%	30439	73%	30676	74%	32924	79%	36291	87%	41610
2012	23497	79%	25598	86%	26022	87%	29996	100%	30266	101%	29893
2013	27769	147%	24052	127%	21683	114%	20774	110%	19130	101%	18948
2014	23024	85%	23286	86%	27967	104%	29328	109%	28629	106%	26942
2015	27621	146%	28729	152%	23125	122%	21906	116%	18856	100%	18882
2016	24286	101%	25579	106%	25886	107%	26440	110%	25401	105%	24116
2017	25181	60%	26766	64%	34589	83%	41579	99%	42323	101%	41883
2018	27399	86%	30472	96%	30462	96%	31817	100%	31592	100%	31676

The Dalles: (Jan-Jul)											
Year	Jan		Feb		Mar		Apr		May		Observed
	KAF	% of OBS	KAF	% of OBS	KAF	% of OBS	KAF	% of OBS	KAF	% of OBS	KAF
2005	85600	105%	82400	101%	70700	87%	73800	91%	74700	92%	81349
2006	101000	88%	111000	97%	107000	93%	107000	93%	110000	96%	114672
2007	105000	110%	101000	105%	100000	104%	100000	104%	99100	104%	95738
2008	102000	103%	103000	104%	103000	104%	101000	102%	97300	98%	99209
2009	94700	105%	92900	103%	86200	96%	92000	102%	91100	101%	90244
2010	88500	104%	79200	93%	71800	85%	69700	82%	70900	84%	84718
2011	99041	71%	105851	73%	111213	72%	119785	79%	126943	89%	142616
2012	86041	66%	93781	72%	98799	76%	114135	88%	120043	93%	129441
2013	102470	105%	92040	94%	89674	92%	90972	93%	92870	95%	97709
2014	90334	84%	79222	73%	95865	87%	105424	98%	105513	98%	108082
2015	102646	123%	103786	124%	91678	110%	96005	115%	86396	103%	83668
2016	94084	96%	95160	97%	102918	105%	104709	107%	104704	107%	97605
2017	96575	70%	93398	68%	108782	79%	130774	95%	136944	100%	137111
2018	99282	84%	111454	94%	113994	96%	117562	99%	122145	103%	118708

The Dalles: (Apr-Aug)											
Year	Jan		Feb		Mar		Apr		May		Observed
	KAF	% of OBS	KAF	% of OBS	KAF	% of OBS	KAF	% of OBS	KAF	% of OBS	KAF
2005	74300	109%	69200	101%	57200	84%	60800	89%	61900	90%	68452
2006	87500	90%	94300	97%	91200	93%	92700	95%	95600	98%	97541
2007	91300	116%	88200	112%	88300	112%	85200	108%	84200	107%	78939
2008	88200	95%	91800	98%	94300	101%	94700	102%	90900	98%	93198
2009	82100	102%	79700	99%	74800	93%	82400	102%	81400	101%	80771
2010	76700	99%	68500	88%	62100	80%	60900	79%	62200	80%	77410
2011	90600	71%	92500	73%	92300	72%	101000	79%	113000	89%	127378
2012	77041	65%	84454	71%	90604	76%	103726	87%	110762	93%	119127
2013	92030	105%	81863	94%	80372	92%	81811	94%	82502	95%	87052
2014	84888	90%	72458	77%	88832	94%	92057	97%	96741	102%	94548
2015	87324	149%	83108	142%	71784	123%	72233	124%	62398	107%	58449
2016	82621	105%	83221	106%	86527	110%	86867	111%	86841	111%	78329
2017	84945	78%	82821	76%	92337	85%	102039	93%	111123	102%	109275
2018	87282	86%	94748	93%	98132	97%	103337	102%	106883	105%	101488

CRFG Roster -- 2018

Revised June, 2019			
Name	Agency	Phone	E-mail
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BLUE	Agency/Branch Director/Manager		
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