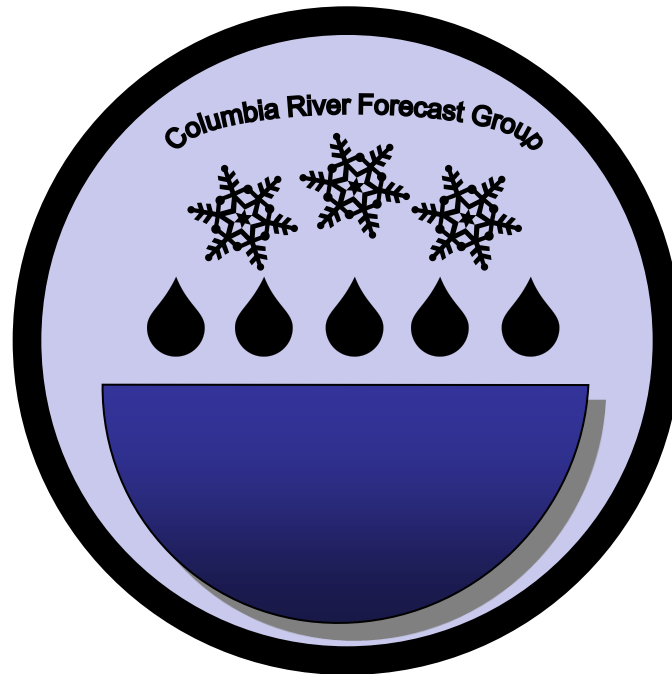


COLUMBIA RIVER FORECAST GROUP

2017 ANNUAL REPORT



CHAIRMAN: ERIK PYTLAK, BPA
VICE-CHAIRMAN: JASON WARD, USACE

JUNE 14, 2018

COLUMBIA RIVER FORECAST GROUP

2017 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 2017 and hosted by CRITFC: March 9, June 22, September 21, and December 8 (annual review). 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
- 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
- Ongoing 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 2017 wrap-up and review of runoff forecasts, comparison of results, discussion of challenges, and lessons learned; and
- Discussion of possible 2018 CRFG activities and work elements

Water Year 2017 was yet another unusual one in terms of both weather and streamflow, with record high precipitation across the basin in October, February, March and April (going back to at least the early 1970s) followed by two months of record low precipitation in July and August. Three cold snaps and two heat waves were noted, and January 2017, was the coldest month in the basin since December 2008. With such cold weather and excessive precipitation, large snowpack accumulated at very low elevations, which then melted during a warm and wet March and led to the highest unregulated March flows on record (going back to 1928). For the fourth time in six years, unregulated flows in the Snake Basin peaked at least a month earlier than the rest of the system.

The keynote speaker of the year was Andy Wood from the National Centers for Atmospheric Research, and former Development and Operations Hydrologist at the Northwest River Forecast Center. His June presentation gave the CRFG a comprehensive update on where the state of the hydrologic science is, and where it appears to be going over the next several years. Hydrologic forecasting is changing rapidly. Forecast methods, models and outputs were fairly static until the past ten years as much better datasets and direct surface observations became available. There is also a growing need to

incorporate modeling uncertainty into ensemble streamflow predictions – not only for more traditional ESPs, but also as short-term streamflow ensembles are being developed.

The CRFG also played a key role in the RMJOC-II research project. Temperature, precipitation, and unregulated flow results were published by the University of Washington in September 2017, which moved the project to a new phase. Stakeholders from the RMJOC-II technical workshops asked CRFG to conduct a more in-depth review of the culling metrics to be used for downselecting the 172 bias corrected scenarios to a more manageable number for hydropower planning and other purposes.

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 and Nancy Stephan, BPA, *RMJOC-II Climate Change Research Project... Forecast/Streamflow Workshop Updates*. Discussion of issues related to the results of the unregulated flow portions of the RMJOC-II project.
- ❖ Andy Wood, NCAR, *NCAR Climate Change and Hydrologic Science Initiatives*. In a follow up to a presentation given in 2016, Andy gave a comprehensive overview of evolving hydrologic forecasting science. While the emphasis was on climate change snowpack trends, modeling and uncertainties in the modeling chain, he also gave an excellent overview on hydrologic model pre- and post-processing which can also benefit short term deterministic and ensemble forecasts.
- ❖ Gus Goodbody, NRCS. Large fires affected SNOTEL sites at Corral Pass and McKenzie Bridge, both of which are in the wettest portions of the Columbia Basin (around 237 inches of liquid precipitation a year).
- ❖ Nancy Stephan (BPA) and Oriana Chegwiddden (UW), *RMJOC-II Climate Change flow publication*. Initial results: Temperatures have already warmed about 1.5°F and are projected to warm another 1-4°F by the 2030s. Precipitation trends are a little more uncertain, but a generally wetter trend is likely with wetter winters but generally drier summers. The April 1 SWE decreases 20-40% by the 2020s and 50-80% in the 2050s. More details will be forthcoming in Part I of the RMJOC-II report in early 2018.
- ❖ Bob Heinith, CRITFC, *CIS*. CRITFC has been working on a Climate Information System (CIS) tool, based off the BPA-developed Hydsim model, to display and quickly evaluate the large number of streamflow scenarios from RMJOC-II – both in daily and 14-period increments.

ACCOMPLISHMENTS

CRFG work accomplishments and ongoing studies or issues that will continue to be addressed in 2018 and beyond:

- RMJOC-II. Now that the project has transitioned from temperature, precipitation and streamflow projection development to hydroregulation studies, CRFG will continue to serve as a technical body to guide the best use of these datasets.
- Climate change. Armed with a new, comprehensive dataset, and with some trends potentially emerging with respect to streamflow behavior, CRFG now has key areas where it can focus its monitoring activities: most notably the potential shift in higher Snake River Basin flows in the late winter and early spring.
- 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. The Canadian statistical forecasts were updated in 2016 to account for early season snowpacks in December and January instead of using just fall precipitation. The statistical forecasts used by USACE at Libby, by Reclamation at Heise, and by CRITFC at The Dalles are all being closely evaluated for updates.

A P P E N D I X 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 - 2015 Meetings

The following meetings took place for the CRFG.

9 March 2017

22 June 2017

21 September 2017

8 December 2017 (Annual Review)

Reviewed and finalized Meeting notes are as follows:

CRFG Meeting Agenda
March 9th, 2017

Meeting time: 8:30 am – 12:30 pm PST

Location: **Columbia Intertribal Fish Commission (CRITFC), Celilo Room (5th Floor)**
700 NE Multnomah Street, Portland

Teleconference: USA Toll-Free: (877)848-7030

USA Caller Paid/International Toll: (404)443-2170

ACCESS CODE: 3626353 SECURITY CODE: 1208

Web Meeting Address: <https://www.webmeeting.att.com> <<https://www.webmeeting.att.com>>

Meeting Number(s): (877)848-7030 or (404)443-2170

ACCESS CODE: 3626353

Contact Info: Erik Pytlak (503-230-5335)
Kyle Dittmer (503-731-1314)

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

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

8:45 – 9:30 **2017 Water Year Forecast Updates (~ 10 minutes each)**

USACE: Joel Fenolio or Kristy Riley (LIB)
Steve Hall (DWR)

Reclamation: Peter Cooper (HGH, upper Snake)

NRCS: Rashawn Tama (systemwide)

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

CRITFC: Kyle Dittmer (TDA)

Others:?

9:30- 9:45 **RMJOC-II Project Delay Update** (Erik)

9:45-10:00 <<<**BREAK**>>>

10:00-12:00 **RMJOC-II Scenario Culling Criteria and Tools** (Nancy, Erik and all)

- Elements we can evaluate with NRNI Climate Change Flows
- Elements we can evaluate with Converted/Modified Flow-like Flows
- Elements we have to evaluate with full hydroregulation studies

12:00-12:15 **2016 Annual Report Update:** Mary and/or Kyle

12:15 **Set next meeting** (May?)

Columbia River Forecast Group – Winter Meeting; March 9, 2017

Introductions:

Chairman Erik Pytlak welcomed everyone at 8:35 AM. The attendees introduced themselves. The December meeting notes were reviewed and approved.

2017 Water Year Forecast Updates

USACE:

Libby- Joel Fenolio - The Seattle District's March (Apr-Aug) forecast is 6.789 Maf which is close to where the forecast was in January after a dip to 5.6 Maf in February. Erik asked, given that the Libby equation did not handle the record October precipitation very well, if Seattle district will review its water supply forecast equation. Joel replied that they will after the season is over.

Dworshak – Steve Hall – The Walla Walla District's (Apr-Jul) forecast is 2.867 Maf. They are planning a format change for next year to round to the nearest 1/10 of a Maf. The early-bird forecast has already increased to 3.2 Maf. Several in the group complimented Walla Walla District for staying on top of the rapidly increasing water supply forecasts, and adaptively managing Dworshak to the conditions, rather than outside pressure.

USBR: Peter Cooper

Hungry Horse – The March (May-Sep) forecast is 1.693 Maf or 100% of normal. Precipitation and SWE in the Upper Snake basin is very high relative to historic average which corresponds to high runoff forecasts. Jackson and Palisades will be drafting over the next two months for flood risk management targets. The Snake River at Heise may see high spring flows with a forecasted March-July runoff of 160% of normal. Good surrogate years: 1986, 1996, and 1997. The flood control rule curve is indicating both Palisades and Jackson will need to be drafted to the maximum flood control space (1,200 kaf for Palisades and 400 kaf for Jackson) by mid-April. – The last time this occurred was in 2011. Expect significant and sustained flows into American Falls and Brownlee for several months.

NWS/NWRFC: Kevin Berghoff

October and February had record precipitation in the Columbia Basin in early WY 2017 while the Upper Snake had high values in October, December-February. Continued periodic communication with USBR on the draft timing and information of irrigation is need by the RFC to improve the Brownlee ESP forecast and elsewhere in the Snake Basin. The ESP Natural forecast historic rank for the Upper Snake: rank 2, 3, 4 (1949-2016). In British Columbia, the SWE jumped 10% in just the last week.

CRITFC: Kyle Dittmer

The Columbia at The Dalles forecast was 101 MAF (Jan-July), 100% of normal using the MEI regression model. Other periods: 81 MAF (Apr-July), 101%; 89 MAF (Apr-Aug), 101%. The MEI index is close to the zero line.

Discussion (all):

Erik Pytlak asked Jason Ward and the USACE team: when does a system flood emergency get declared in the Columbia Basin? The CBWM chief, Steve Barton, declares the system flood emergency and Division takes a lead on coordination and communication of system operations. More information will be provided at an upcoming meeting.

RMJOC II Project Delay Update: Erik Pytlak

There were errors found in the way irrigation volumes were added to the historic no regulation/no irrigation (NRNI) streamflow data that was provided to University of Washington (UW) by the RMJOC. There was a high bias in the streamflows in the Snake and Yakima basins that will require a recalibration of the UW hydrologic model. This error will result in a delay of approximately 3-4 months to deliver the final streamflow datasets.

RMJOC II Scenario Culling Criteria and Tools: (Nancy Stephan, Erik Pytlak, All)

Nancy presented a brainstorming proposal on the type of analysis that is preferable on calibrated no regulation/no irrigation (NRNI) streamflow data from UW and hydro-regulated streamflow data. A subset of the datasets will be selected by the RMJOC operating agencies via a culling process using prioritized hydrologic characteristics with input from stakeholders. Clustering tools and visuals of streamflow, temperature, and precipitation were presented by Nancy and Erik. A visual “quilt” was presented by Chris Frans (USACE, Seattle District) that will be used as tools in the culling process. BPA and USACE asked for post meeting input from NOAA Fisheries and CRITFC on a prioritized list of hydrologic characteristics to consider in the culling process. The group was asked to provide their top three elements that should be considered for the NRNI bias corrected climate change flows/Modified Flow-like converted flows, and for full hydroregulation studies by the end of March.

2016 Annual Report Update: Kyle Dittmer and Mary Mellema

Kyle reported that Mary is working on the report. More details soon.
The next CRFG meeting will be scheduled for mid-June 2017. The meeting was adjourned at 12:15 PM.

Attendance:

Anderson, Bruce - NWS/NWRFC (Portland)
Austin, Bob – USRT (Portland)
Berghoff, Kevin – NWS/NWRFC (Portland)
Cooper, Peter – USBR (Boise)
Dittmer, Kyle – CRITFC (Portland)
Fenolio, Joel – USACE (Seattle)
Frans, Chris – USACE (Seattle)
Hall, Steve – USACE (Walla Walla)
Heinith, Bob – CRITFC (Portland)
Pytlak, Erik – BPA (Portland)
Stephan, Nancy – BPA (Portland)
Wagner, Paul – NOAA Fisheries (Portland)

Ward, Jason – USACE (Portland)
Wisco, Romeo – CRITFC (Portland)

Note-taker and vice-chair: Jason Ward, US Army Corps of Engineers, Portland, Oregon

CRFG Meeting Agenda
June 22nd, 2017

Meeting time: 8:30 am – 12:30 pm PST

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

700 NE Multnomah Street, Portland

Teleconference: USA Toll-Free: (877)848-7030
USA Caller Paid/International Toll: (404)443-2170
ACCESS CODE: 3626353 SECURITY CODE: 1208

Web Meeting Address: <https://www.webmeeting.att.com> <<https://www.webmeeting.att.com>>
Meeting Number(s): (877)848-7030 or (404)443-2170
ACCESS CODE: 3626353

Contact Info: Erik Pytlak (503-230-5335)
Kyle Dittmer (503-731-1314)

8:30 am Welcome and Introductions (Erik)

8:40 Approval March Minutes (all)

8:45 – 9:30 2017 Water Year Updates (~ 10 minutes each)

USACE: Joel Fenolio or Kristy Riley (LIB)
Steve Hall (DWR)
Reclamation: Peter Cooper (HGH, upper Snake)
NRCS: Rashawn Tama (systemwide)
NWS-NWRFC: Kevin Berghoff (or alternate) (systemwide)
BPA: Erik Pytlak (systemwide)
CRITFC: Kyle Dittmer (TDA)
Others: ?

9:30- 10:00 RMJOC-II Project and Culling Criteria Update (Erik and Nancy)

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

10:15-12:00 National Center for Atmospheric Research (NCAR) Climate Change Modeling Initiatives

Guest Speaker: Andy Wood, NCAR

12:00-12:15 2016 Annual Report Update: Mary and/or Kyle

12:15 Set next meeting (September)

Columbia River Forecast Group – Spring Meeting; June 22, 2017

Welcome and Introductions:

Approval of March Meeting Minutes (all)

2017 Water Year Forecast Updates:

USACE:

Libby– Joel Fenolio – Seattle District’s June (April-August) forecast is 7.6 Maf or 130% of average. High October precipitation occurred then lower than normal in November and December. June appears to be on track to be ~ 90% of average precipitation. WY 2017 looks like the coldest winter since 1992 or 1984 with a healthy May snowpack and higher soil moisture resulting in peakier inflows. Approximately 0.5 Maf was lost between May and June in the forecast. There was a similar trend in ESP and the LIB WSF statistical forecasts through the season.

Dworshak – Steve Hall – Walla Walla Districts’ (Apr-Jul) forecast is 2.84 Maf. There is only 4% snow covered area remaining as of last week. The persistence of near 10 kcfs baseflow was baffling with a 6°F rise in temperature observed in the basin. Erik Pytlak remarked that the high fall precipitation may help explain some of the higher than normal baseflows.

USBR: Peter Cooper – Snake R. at Heise and Hungry Horse data were presented. He noted a warm, dry May and a cold June.

October 2016 - June 2017 precipitation was highest observed along with 1997 in the middle Snake basin. There has been a warm and cooler oscillating temperature pattern resulting in a prolonged snowmelt signal.

Heise - for the 1911-2017 period, the second highest unregulated flow to 1997 was observed at Heise at 142% of normal. A volume of 5,644 kaf (1Oct2016-current) was reported. Month – July PCA WSF was higher than other WSFs.

Hungry Horse- Month –July was 120% of average. The trends noted at Libby for a healthy May snowpack were echoed.

NWS/NWRFC- Kevin Berghoff – Colder temperatures and generally wetter in 2017 vs 2016 were shown throughout the Columbia Basin. WY 2017 % of average SWE was shown with new records in the Snake Basin and several sites in the top-5 historically. There was high amounts of low level snow in 2017 as evidence NHRSC values and CoCoRAS observed SWE values. Some anecdotal reports of flooding due to ponding in low lying areas of agriculture fields and roofs collapsing on sheds from high snow loads. There was likely higher than average amounts of high elevations snow above the SNOTEL stations which contributed to high baseflows late into the freshet.

Kyle Dittmer asked if the ENSO signal could have indicated how the year would have hedged. Kevin responded that the weak La Niña year has the biggest range of variability

for above and below average water supply volumes so it's hard to have seen going into the season how it would play out.

Close communication and coordination with the USBR regarding diversion estimates and reservoir operations has improved Snake basin ESP forecasts.

NRCS – Rashawn Tama – Agreement on the data trends identified by the previous speakers and nothing major to add on how the winter and spring have looked hydrologically. Feedback is still desired from users on the Beta Interactive Map hosted by NRCS on their website.

BPA – Erik Pytlak – Daily ESP forecasts help internal planning during the volume run-ups observed this year. A BPA intern, Travis Roth (OSU Ph.D. candidate) is doing a comparison study of snow pack in areas with canopy cover vs. open areas to try to help interpret snow remote sensing data more effectively. The work is being done in lumped manner for each basin to try to capture more information on low and high level snowpack outside of the SNOTEL monitored areas.

CRITFC- Kyle Dittmer – the MEI (Apr-Jul) forecast did not perform well in the later part of this season (winter). Kyle has noticed an increasing disconnect (ocean and atmosphere) between MEI and the seasonal volume since 2001 affecting model performance. He said the forecast is primarily used for early season planning in the winter but there may more investigation to improve model skill upcoming.

Discussion (all):

RMJOC-II Project and Culling Criteria Update (Erik Pytlak and Nancy Stephan)

The RJMOC-II technical teams at BPA, USACE, and USBR are reviewing provisional 0.9 as it's being released by University of Washington (UW). The VIC modeling preliminary results were shown for the 50% of freshet day vs. volume was shown. The timing of the peaks looks pretty good compared to the historical period, but there are some remaining bias correction issues that still need to be resolved. Average streamflow comparisons of the 2030s vs. 2070s show intuitive trends in the data of earlier peak timing and lower summer flows.

Remaining issues to address: Dynamically downscaled data is apparently biased too warm relative to the historical period, while the BCSD and MACA downscaled sets appear to be biased too cool in parts of the basin. PRMS modeled data was just released (at meeting time) so additional review continues. Lessons learned on the tradeoffs of monthly vs annual bias correction techniques are showing that the historic streamflow timing is not as helpful (for intra-season purposes) as a guide as thought in RMJOC I. Differences are still trying to be resolved and feedback will be provided by the team to UW.

The timing for upcoming workshops and RMJOC-II technical team culling decisions was presented for CRFG awareness. All datasets should be available by 31 July 2017 with culling finalized by 5 Sept 2017. Input received from CRFG members on culling parameters was appreciated and incorporated. The categories were Power, Ecosystem,

and FRM (Flood Risk Management). The objective is that the regulated culled dataset can still represent the overall distribution of streamflow and temperatures in the larger 172 datasets from RMJOC II.

National Center for Atmospheric Research (NCAR) Climate Change Modeling Initiatives (Andy Wood)

Andy Wood gave a detail-rich presentation on NCAR’s ongoing efforts for Hydrology and Climate Applications, Model frameworks and Meteorology, Climate Change, and Streamflow forecasting approaches. The presentation is 90MB and will be made available to participants for reference. In brief, historical forcings started in 1970 using mostly deterministic data (i.e., observations, radar data). A 100-member ensemble at a 1/16-degree grid scale was used. Model calibration raised issues – can the transfer of parameters to other basins be realistic? What about sub-grid variability? They used the Multi-Scale Parameterization Regionalization method. We need more model range as a tool to capture more uncertainty (specifically heterogenous physiographic terrain).

2016 Annual Report Update: Peter Cooper for Mary Mellema and Kyle Dittmer

Peter said that Mary is working on the report and it will be available soon. Real-time operations this year have delayed the completion of the report to date but that should improve in the next quarter.

Set next meeting- September 21, 2017 was proposed likely as a web meeting with optional attendance at CRITFC. Kyle confirmed the date after our meeting and booked a room.

The meeting was adjourned at 12:15 PM.

Attendance:

Last	First	Agency	Location
Berghoff	Kevin	NWS-NWRFC	Portland
Cooper	Peter	USBR	Boise
Dittmer	Kyle	CRITFC	Portland
Dixon	Taylor	NWS-NWRFC	Portland
Duffy	Keith	USACE	Portland
Fenolio	Joel	USACE	Seattle
Frans	Chris	USACE	Seattle
Garen	David	NRCS	Portland
Graves	David	CRITFC	Portland
Hall	Steve	USACE	Walla Walla
Kunkel	Mel	Idaho Power	Boise

Morrill	Charles	WDFW	Portland
Pytlak	Erik	BPA	Portland
Stephan	Nancy	BPA	Portland
Tama	Rashawn	NRCS	Portland
Wagner	Paul	NOAA	Portland
Ward	Jason	USACE	Portland
Wills	David	Public	Portland
Wood	Andy	NCAR	Boulder

Note-taker and vice-chair: Jason Ward, US Army Corps of Engineers, Portland, Oregon

September 21st, 2017

Meeting time: 8:30 am – 12:00 pm PDT

Location: **Columbia Intertribal Fish Commission (CRITFC), Celilo Room (5th Floor)
700 NE Multnomah Street, Portland**

Teleconference: USA Toll-Free: (877)848-7030

USA Caller Paid/International Toll: (404)443-2170

ACCESS CODE: 3626353 SECURITY CODE: 1208

Web Meeting Address: <https://www.webmeeting.att.com> <<https://www.webmeeting.att.com>>

Meeting Number(s): (877)848-7030 or (404)443-2170

ACCESS CODE: 3626353

Contact Info: Erik Pytlak (503-230-5335)
Kyle Dittmer (503-731-1314)

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

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

8:50-9:15 **Approve 2016 Annual Report** (all)

9:15-10:00 **RMJOC-II Climate Change Updates**

Overview of finalized unregulated flows (Erik, Bart, Oriana) and publication
website

Preliminary Findings Statements

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

10:15-11:30 **RMJOC-II Climate Change Updates**

Culling process, and initial culled set selection (feedback due Oct 6)

Draft report outlines and initial publication timeline

Set date for RMJOC-II Technical Transboundary Workshop (see below)

11:30-12:15 **2017 Water Year Updates; Changes in 2018? (~ 10 minutes each)**

USACE: Joel Fenolio or Kristy Riley (LIB)

Steve Hall (DWR)

Reclamation: Peter Cooper (HGH, upper Snake)

NRCS: Rashawn Tama (systemwide)

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

BPA: Erik Pytlak (systemwide)

CRITFC: Kyle Dittmer (TDA)

12:30 **Set next meeting (November 30?); and RMJOC-II Transboundary Workshop**

Columbia River Forecast Group – Summer Forecast Meeting; September 21, 2017

Introductions:

Acting Chairman Jason Ward welcomed everyone at 8:30 am. The attendees introduced themselves. Chairman Erik Pytlak was absent due to a family emergency. The June meeting notes were updated with comments and reviewed by members. Jason asked the members present to approve the revised notes. It was moved (Kyle) and seconded (Steve) to approve – we did so.

Approval of the Annual 2016 CRFG Report:

Some members did review the document. It was moved (Steve) and seconded (Peter) to approve – we did so.

RMJOC-II Climate Change Updates, Nancy Stephan (BPA):

These are preliminary findings, based on the UW work, of new climate change streamflow datasets using IPCC-5 (2013) data to provide realistic sets of future scenarios. This \$1.49 million project (spanning 4-years) has better accuracy and quantification of hydro model uncertainty, plus a bigger range of climate outcomes. Methodology: GCMs + Historical observations → downscaling → hydro-models (calibration) → hydro-regulation.

Historical period: 1976-2005. Hydro models PRMS (USGS) and UW-VIC performed better than the NCAR-VIC and ORNL-VIC runs. A late snow-melt bias does have some impact on BC basins. The NRNI dataset has the irrigation depletions reinserted (but no regulation). The UW used the KGE (“good fit”) metric during the 1992-2001 calibration. Kevin – is there a snow-melt bias in the Upper Columbia or just the Snake basin?

Dynamic downscaling used PRISM data (ORNL). The warm bias carried through. The 2030s dynamical vs. statistical downscaled streamflow is very different and even warmer than the 2970s BCSD and MACA bias-corrected flows. Jason – what about winter dynamic forcings? Oriana – historical bias-corrections can push a bias around. The dynamic downscaling can “go off on its own.” Sept. 21 through October is the public comment period. By Oct. 16, the culled data should be finalized. Late November may be the RMJOC-II Workshop.

Results: for temperature and precipitation, we used the RCP 4.5 (moderate) and 8.5 (high) emission scenarios, 10 GCMs, and three downscaling methods, for the 2030-2099 period to make 172 runs. For RCP 4.5, winter/spring sees a +4 degF change; +5 degF summer; wetter winter/spring and drier summer. More warming occurs in the Columbia interior rather than the coast. Precipitation trends are a little more uncertain, but a generally wetter trend is likely. The April 1 SWE drops 20-40% in the 2020s and 50-80% in the 2050s.

Peter – is there more snow in February or March, due to shifts in the Jetstream? Oriana – a few GCMs show more higher elevation snow deposition even as snow melts elsewhere. Mica BC – the spring peak is 1-2 weeks early (2030s) and 2-3 weeks early (2070s), with a higher spring peak and less summer flow. In the 2070s, flow is higher in March-May while June-August decreases. Grand Coulee GCL – we see a 2-week early shift (2030s) with an increase in flows during November-April while July-August declines. Lower Granite LWG sees the biggest change – a 2-3 week shift (2030s) then a 4-week shift (2070s), with a multiple peak in January-May. The flows increase in November-March and decrease June-August. Bob – will variability be higher? Oriana – there is big

variability in temp./precip. in the Snake system. In the 2030s, both RCPs give similar results then diverge in the 2070s. Even the Willamette is showing similar trends although it is much less a snow-dominated system. A draft report outlining procedures, lessons learned, and sector results may be ready by early 2018.

Culling process update: looking at 2030s, RCP 8.5, MACA and BCSD downscaling methods, 14 dams, six volume metrics (e.g., center-of-timing), and GCMs (bookends, mid-range). A matrix table shows the trade-offs. Oct. 12 is the comment deadline. Bob – what about Canadian usage and analysis? The Canadians are ready to look at the results. They are running a modified VIC for their glaciers. Bob – how does the Canadian VIC model glacier-component compare with the UW-VIC? Oriana – the BC-VIC has glaciers moving (i.e., dynamic flow) whereas the UW-VIC uses volume/area relationships.

Updates of 2017 Forecasts:

Libby LIB, Joel Fenolio, COE-Seattle. The April-August forecast was 7 MAF, 120% of normal. Initial soil-moisture was very high. Basin snow-pack was ~140% of normal.

Dworshak DWR, Steve Hall, COE-Walla Walla. The April-July forecast was 2.8 MAF. Similar weather patterns here, like Libby, but with a dual peak – the big one in March (**48 kcfs**). We are considering a recalculation of new runoff period – March-June – to help operations.

Upper Snake, HGH, Peter Cooper, USBR. Upper Snake went from very wet winter/spring to dry summer. SNOTEL values dropped fast in May-June. For Hungry Horse HGH, the March inflow was the second highest ever while the August inflow was in the 10th lowest (1928-2017). The May-June forecast was suspect – too high. Kevin – what about the recharge program? Idaho Water Resources tracks the flows. It is about 250 KAF on average with 50-100 KAF coming from private irrigation companies.

Columbia basin, Gus Goodbody, NRCS. The water supply forecast team: Gus (Upper Columbia), Rashawn Tama (Montana; Snake system), Dave Garen (Oregon). Fire impacts did hit SNOTEL sites Correl Pass, McKenzie Bridge. Do you know the highest average precipitation site? We were stumped. Turns out to the south side of Mt. St. Helens – with its closer proximity to the Pacific Ocean and few obstructions coming up the lower Columbia River. Top sites are June Lake and Swift Lake – 237 inches in 2017. We are reviewing statistical methods – periods, length, stationarity, etc. The Agriculture Research Service has a snow model we use to monitor ground conditions. There is a LIDAR collection method used in California. Can we use it in the PNW? A test study is being prepared for the Boise basin.

Columbia Basin, Kevin Berghoff, NWRFC. Spring was very wet and snowy then rapidly dried out. Columbia at The Dalles TDA came in at 107%. The Snake basin was in the top 5 or 10 years. Weather patterns were unusual – a dry November-January period followed by strong rain and snow events in February-April. The April-September TDA runoff was 122%. The National Water Model is a work-in-progress (WARF model with GFS forcing).

Columbia Basin, Rick van der Zweep, BPA. The ESP forecast declined this summer, as was similar to the NWRFC forecasts. The LWG peak was in mid-March and high again in late May. We look at a 31-member (i.e., ONI, PDO, PNA, etc.) climate index. We use a subset of the ESP runs to create a synthetic year to match the 60-year ESP trace. We see mixed results so far. For short-term ensembles, we use the HEFS model.

Upper Columbia Basin, BC Hydro, no report, no representative.

CRITFC Information System (CIS), Bob Heinith, CRITFC contractor. Kyle deferred his time over to Bob for an update of CIS efforts. The CIS is a MS Access-based version of HydroSim that allows for better and easier use of the model and its displays. CRITFC has done a short preliminary look at the new UW datasets and compare with the NRNI data. The climate change scenarios are based on seasonal/monthly/yearly periods. They can look at 14-periods or daily data. They will review 19 runs and are ready to run their own hydro-regulation studies as needed.

Other Business/Wrap-up: Next meeting set for December 8th (Friday) at CRITFC's Columbia Room (confirmed). Jason adjourned the meeting at 12:30 pm. He thanked all for participating.

Attendance:

Berghoff, Kevin – NOAA NWS/NWRFC (Portland)
Cooper, Peter – USBR (Boise)
Dittmer, Kyle – CRITFC (Portland)
Goodbody, Gus – NRCS (Portland)
Graves, David – CRITFC
Hall, Steve – COE-Walla Walla
Heinith, Bob – CRITFC Consultant
Hua, Daniel – NWPCC (Portland)
Stephan, Nancy – BPA (Portland)
Ward, Jason, COE-NW Division
van der Zweep, Rick – BPA (Portland)

On the phone:

Benner, Dave – FPC (Portland)
Chegwidden, Oriana – UW-Seattle (Dept. of Civil/Environmental Engineering)
Fenolio, Joel – COE-Seattle
Frans, Chris – COE-Seattle
Pickett, Paul – Washington DOE

IPCo Rep: Frank Gariglio

Alfredo Rodriguez, COE-Walla Walla

Note-taker: Kyle Dittmer, Columbia River Inter-Tribal Fish Commission, Portland, Oregon

**CRFG Meeting Agenda
December 8th, 2017**

Meeting time: 8:30 am – 1:30 pm PST

Location: **Columbia Intertribal Fish Commission (CRITFC), Celilo Room (5th Floor)
700 NE Multnomah Street, Portland**

Teleconference Info

Teleconference: USA Toll-Free: (877)336-1839
ACCESS CODE: 5336759

Web Meeting Address: <https://www.webmeeting.att.com>

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

ACCESS CODE: 5336759

Security code (if asked): 1234

Contact Info: Erik Pytlak (503-230-5335)
Kyle Dittmer (503-731-1314)

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

8:40 **Approval September Minutes** (all)

8:45 **2017 Water Year (~ 15 minutes each)**

USACE: Joel Fenolio or Kristy Riley (LIB)
Steve Hall (DWR)

Reclamation: Peter Cooper (HGH, upper Snake)

NRCS: Rashawn Tama (systemwide)

BC Hydro: ??

9:45-10:00 << **BREAK** >>

10:15 **2017 Water Year, Continued**

NWS-NWRFC: Kevin Berghoff (systemwide)

BPA: Erik Pytlak (systemwide)

CRITFC: Kyle Dittmer (TDA)

Others?

11:00-11:15 Discussion about 2017 and lessons learned

11:15-12:00pm << **LUNCH** >>

12:00pm **2018 Water Year Plans, New Products/Services, New Procedures**

USACE Seattle: First Libby WSF for 2018

CRITFC: 2018 WSF

NWS NWRFC:

BPA: 2020 Modified Flows and Short-Term Ensemble
Development

Others?

1:00 **The Sampler** (Salmon managers odds-and-ends, other items to note for 2017))

1:30

**Transition leadership (Jason Ward to Chair, Peter Cooper to Vice-Chair)
Set next meeting**

Columbia River Forecast Group – Fall Forecast Meeting; December 8, 2017

Introductions:

Chairmen Erik Pytlak welcomed everyone at 8:30am. The attendees introduced themselves. Chairman Pytlak thanked vice-chair Jason Ward and Kyle Dittmer for filling in to lead and take notes at the September 21, 2017 meeting during his absence. The September meeting minutes were updated with comments and reviewed by members. Erik asked the members to approve the revised notes. It was so moved (Kyle) and seconded (Jason) to approve and they were approved as final.

2017 Water Year Water Supply Forecast (WSF) Summaries:

Libby – Joel Fenolio, COE – Seattle District

WY 2017 was year of precipitation variability with well above average precipitation in the Kootenay Basin in October 2016 (400-600% of normal) followed by dry conditions in November through January. February through April then brought above average snowfall while temperatures were well below average for December through February and cold enough in March and April for a large snowpack to continue to build similar to 2012. Above normal rainfall in winter and spring resulted in saturated soils in the basin and elevation runoff responses from snowmelt and spring/summer precipitation.

Joel summarized the monthly forecasts for Libby and the precipitation and SWE observed inputs. October precipitation was 5 standard deviations above the mean and capped to 2 standard deviations which was comparable to the period of record maximum in the training period. The forecast would have been approximately 0.5 to 1 MAF off without the adjustment for any given month. May snowpack was approximately 150% of average follow by a dry summer. The April and May ESP forecast showed better performance relative to the observed April-August volume by accounting for the low summer precipitation. June to September had a period of no measurable precipitation in the Libby basin for 80 days. In summary there was high degree of variability in 2017 in terms of hydrometeorology.

The NWRFC is preparing an ESP hindcast back to 1984 to help Seattle District evaluate difference in forecast error and skill throughout the season for the Libby WSF. More to come as this study will likely be a 1-2 year effort.

Dworshak – Steve Hall, COE- Walla Walla District

WY 2017 was the year of low elevation snow in the basin. Shangai summit, a lower elevation Snotel station at 4570 feet elevation, was clearcut by a timber company and the 2017 SWE plot seems to show a faster melt off than normal this year. The April-July WSF comparison showed the official forecast comparing fairly well in terms of skill this year. The official WSF was closer than the Z-score forecast in March and April and then they both tracked closely to ESP and observed in May and June. Due to low elevation snow March inflow was very high this year. The March-June volume was 4 MAF while April-July volume was 2.9 MAF. Walla Walla District is interested in some evaluation of this earlier runoff timing shift in the period of record with some comparison of the April-July to March-June seasonal volume. Erik Pytlak raised a question of what it would take to change the official forecast period and storage reservation curves at Dworshak. Jason

Ward responded that one year does not necessarily necessitate a change to the SRDs but ongoing RMJOC II climate change work will likely inform a vulnerabilities assessment of current operating rules with earlier runoff timing.

Low elevation snow is difficult to measure. There are no Snotel stations that capture it, SNODAS is not helpful beyond a qualitative indicator, and snow bridging at precipitation gages often prevents measurements of measurable snowfall which reduces the effectiveness of using those gages as indicators of low elevation snow.

The Headquarters precipitation gage was missing in preparing the December 2017 WSF. The NWS has some changes of roles on the data telemetry. It looks to be available now after coordinating with NWS. Walla Walla District is a paying cooperator for that gage.

Upper Snake and Hungry Horse – Peter Cooper, USBR- Boise Upper Snake - December through April brought above normal precipitation and below normal temperatures resulting in a big snowpack. April and May included record high precipitation. April cooled off delaying the inflow peak into May where snow melt began. The second highest inflow (1911-2017) occurred in WY2017 with only 1997 being higher in the upper Snake. The April to July observed volume for the Snake at Heise was 5.35 MAF while 3.3 MAF is the 30-year normal.

Hungry Horse – WY2017 was again the year of extremes in the basin. October had the 3rd highest inflow, the 2nd highest March, and 10th lowest August for the period of record (1928-2017). The precipitation and temperature trends in the basin were similar to those described for Libby by Joel Fenolio. The adopted forecast for Date-July was compared to the NRCS, NWRFC ESP forecast, MLR, and PCA forecasts.

New products being developed: USBR is in the very early staging of investigating a potential WSF update for Heise. Mark Porter with USBR, formerly of Los Alamos, is working on Date-July forecast using the Python Model Analysis toolkit to optimize independent variable weights in MLR forecasts.

Mica, Arrow, and Duncan – Georg Jost, BC Hydro

Highlights of Water Year 2017 were high fall precipitation and a dry summer with glacier melt as a major contributor to baseflows and extreme wildfires. At Mica approximately 5% of the basin is covered in glaciers which yields 40-50% of the August flow. Snow pack was 90-110% of normal. There was a weak La Niña which transitioned to neutral conditions over the winter. Generally, ENSO has a small impact on the 2016 WSF regression equations.

2016 Update to Treaty project statistical forecasts

The last update was in 2006. The 2016 update used a similar PCR methodology with a training period of 1984-2015. Snowpack is now included in the January WSF and the December and January forecasts incorporate Jan.-July volume instead of Feb.-July. Standard errors are higher in the early and mid-season predictor dates due to increases in predictive uncertainty with the addition of recent climate data. Over the same training period, the new forecast has lower standard errors than the previous model.

Some developmental efforts are underway at BC Hydro of doing ESP of ESP traces to better capture uncertainty at the tails (e.g. > 90 percentile) of the forecast distribution.

Northwest River Forecast Center, Kevin Berghoff

There was higher precipitation in WY2017 than in WY2016 overall in the Columbia basin particularly in the Middle and Upper Snake basins and west of the Cascades. October brought well above average precipitation, November was dry basinwide, followed by below average Dec.-Jan. precipitation in the Upper Columbia but above normal precipitation in the Snake Basin with below normal temperatures which led to a large low-level snowpack. February and March had above average temperatures in the Snake causing an early melt of low level snowpack. The Lower Granite contribution of streamflow volume at TDA was higher than normal in Feb. and March. March was 48% where normal is 41%. Oct-Nov precipitation in WY 2018 was slightly above normal (~110% normal) but lower than the high values in WY2017 up to 156% of normal. The Climate Index Tool was featured and monthly WSF briefings for WY2018 will begin in January 2018. Paul Wagner asked about citizen science and ways that volunteer measurements are used by the NWRFC and concern that the Avalanche Center stops issuing advisories in April. Kevin mentioned the CoCoRAS network is used qualitatively and for ground truthing of SNODAS remote sensing data. For additional community engagement, letters to representatives are needed to stress the importance of maintaining funding for measurement networks. NRCS has said they are at only 50% of capacity for staffing in their snow monitoring program. Ryan Lucas mentioned the MPing app is NOAA supported and allows citizens to upload weather observations.

BPA, Erik Pytlak WY 2017 was the “Year of Superlatives” with high variability of precipitation and temperatures. The fastest run-up in Jan-Jul WSFs on record occurred since 1980. Six of twelve months set new precipitation records (both high and low). Three cold snaps and two PNW heat waves were noted by BPA. Jan 2017 was the coldest month since Dec 2008. WY 2017 was the 11th highest water volume year on record since 1928. March monthly average flows were a new record across much of the basin. The freshet timing of the Snake was approximately one month earlier than the Upper Columbia. This was the fourth time in six years that peak Snake flows occurred several weeks earlier than Upper Columbia peak (2012, 2013, 2015, 2017), with double Snake Basin peaks in all six years. That could be a climate change signal which should be closely monitored. Weak La Niña episodes like that of 2017 tilt the odds toward slightly higher Jan-Jul runoffs in the Columbia Basin, but some of the highest AND lowest volume years occurred during weak La Niña episodes

CRITFC – Kyle Dittmer

The 2017 Water Supply Forecast (MEI method): Columbia R. at The Dalles, Jan.-July: 111 MAF (pre-season, issued Oct. 2016), 109%. Observed: 137 MAF. Error \pm 19%. For April 2017 (last in-season), 101 MAF, 100%. Observed: 137 MAF. Error \pm 26%.

For WY 2018, MEI suggests La Niña. PDO – the Cold phase continues. The Columbia River Gorge, Mt. Hood and Portland winter forecasts were presented – colder, wetter than normal. Government Camp: Expect a seasonal total of: 266-inches or 119% of normal

(Nov.-May). WSF, using average of 20-surrogate years: **112 MAF** (± 14 MAF) or 109%, Columbia River at The Dalles, Jan. - July. Expect five snow events in Portland: 3 moderate (3-4 inch apiece) and 2 minor (0.5-1 inch apiece).

Discussion about 2017 and lesson learned:

Low elevation snow continues to be challenging to monitor. Others lessons were mentioned above in the water year reviews.

2018 Water Year Plans, New Products/Services, New Procedures

Windy.com was introduced by Steve Hall to the group as a nice visual of wind vectors/steering currents in the atmosphere.

Kyle and CRITFC are investigating a Columbia at The Dalles WSF using a three-month lagged value for the ONI climate index (http://origin.cpc.ncep.noaa.gov/products/analysis_monitoring/ensostuff/ONI_v5.php). He will run that ONI forecast in parallel with their MEI forecast for WY2018, then do an end-of-year evaluation. The ONI is the official ENSO tracking index that NOAA uses these days.

NWRFC- The National Water Model continues to progress and Hydrologic Ensemble Forecasting System (HEFS) seems to be helping with West-side (i.e., rain driven) flood forecasting. ESP forecasts are now using 1949-2017 (68 traces) at the NWRFC.

BPA- Experimenting with using AWIPS-2 to downscale temp and precipitation from ensemble weather models (GEFS and SREF) at 0-14 days. 2020 Modified Flows 2020 Update- PNCA requirement to update unregulated streamflow dataset once every 10 years for power planning, and for us by RMJOC for planning studies. The 2020 Modified Flows Dataset will run through WY2018. USDA 5-year crop census data is used for irrigation/depletion estimates. New ground sprinkler irrigation has increased in the basin which is more efficient and may have less return flows. USBR and BPA have contracted with Washington State to do a depletion case study in the Umatilla Basin to assess irrigation and return levels of 3 type of irrigation including the new technique. The 2020 Modified flows data-set delivery is planned for 2021. PNCA project owners are submitting data annually now except for USBR and BC-Hydro for some locations.

Shifting of seasonal WSF period and some evaluations are planned. We will look at the potential of ESP based forecasts as official forecasts for the remainder of projects currently using statistical forecasts.

John Hildreth - Idaho Power Company is using the FEWS system and Riverware. They will continue do gain experience with those tools in WY2018.

The meeting concluded with thanks for Erik Pytlak for serving as chairman in 2017. The chair duties will pass to Jason Ward with USACE for 2018 and Peter Cooper with USBR as vice chair.

The next CRFG meeting will be schedule, 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:

Berghoff, Kevin – NOAA NWS/NWRFC (Portland)

Lucas, Ryan – NOAA NWS/NWRFC (Portland)

Hildreth, John – IPC (Boise)

Cooper, Peter – USBR (Boise)

Dittmer, Kyle – CRITFC (Portland)

Jost, Georg – BC Hydro (Vancouver)

Hall, Steve – COE-Walla Walla

Bach, Leslie – NWPCC (Portland)

Pytlak, Erik – BPA (Portland)

Smith, Stephanie – BC Hydro (Vancouver)

Wagner, Paul – NOAA Fisheries (Portland)

Ward, Jason, COE–NW Division (Portland)

On the phone:

Fenolio, Joel – COE-Seattle

Note-taker: Jason Ward, CRFG vice-chair, US Army Corps of Engineers, Portland, Oregon

Appendix C

Historical forecast results

Columbia River Forecast Group 2017

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: 4th 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

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

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	132%	1418	114%	1144	92%	1217	98%	1173	94%	1245
2006	1826	101%	2024	112%	1958	108%	1912	106%	1824	101%	1811
2007	1823	136%	1803	135%	1786	134%	1495	112%	1425	107%	1337
2008	1840	76%	1859	77%	1876	78%	1913	79%	2131	88%	2410
2009	1809	112%	1864	115%	1697	105%	1817	112%	1816	112%	1618
2010	1654	103%	1429	89%	1284	80%	1305	81%	1345	84%	1608
2011	1944	61%	2139	67%	2222	69%	2357	73%	2798	87%	3212
2012	1691	80%	1781	85%	1739	83%	1906	91%	1680	80%	2102
2013	1968	106%	1877	102%	1743	94%	1750	95%	1789	97%	1849
2014	1787	73%	1819	75%	2142	88%	2204	90%	2400	99%	2436
2015	1977	214%	1927	208%	1678	181%	1496	162%	1499	162%	925
2016	1629	135%	1531	127%	1573	131%	1556	129%	1251	104%	1203
2017	1828	106%	1489	86%	1691	98%	1769	103%	2018	117%	1725

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

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

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

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

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

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

CRFG Mailing List -- 2017

Revised December, 2017			
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