Northwest Power and Conservation Council

June 30, 2011

MEMORANDUM

TO: Council members

FROM: Jim Ruff – Manager, Mainstem Passage and River Operations
John Fazio, Senior Power Systems Analyst

SUBJECT: Briefing on Analysis of Climate Change Effects on Columbia River Hydrosystem

At the July 13, 2011, Council meeting in Portland, a panel of federal agency representatives will brief the Council on their recently completed modeling analysis of climate change effects on the Columbia/Snake River hydropower system. Included on the panel will be Jim Barton from the Northwestern Division of the Corps of Engineers (Corps), Pat McGrane from the Bureau of Reclamation's (Reclamation) Boise office, and Rick Pendergrass from the Bonneville Power Administration (Bonneville).

The Corps, Reclamation and Bonneville collaborated on developing an array of climate change and hydrology datasets and hydrosystem modeling efforts in support of their longer-term planning activities in the Columbia-Snake River Basin. This effort was led by the federal River Management Joint Operating Committee (RMJOC), a forum consisting of water managers, hydrologists, and power schedulers from Reclamation, the Corps, and Bonneville.

The RMJOC meets regularly and evaluates operational and/or infrastructure actions that may impact dam operations in the Pacific Northwest. This collaboration also included input from many stakeholder agencies, including staff from the Northwest Power and Conservation Council, U.S. Fish and Wildlife Service, NOAA, Columbia River Inter-Tribal Fish Commission, and others so that their perspectives could be incorporated throughout this analytical effort.

This study focused on how climate change could impact hydrology and water supplies in the Columbia River Basin, and how supply-related impacts may affect project facility operations conducted by the three federal agencies. The information developed in this effort will be used for future analyses such as the Columbia River Treaty 2014/2024 Review and other potential studies. Climate change effects on water demands and project operating constraints are being assessed in ongoing research and potential follow-up collaboration.

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RMJOC Climate Change Initiative Briefing to NWPCC

Presented by:

Rick Pendergrass – Bonneville Power Administration

Pat McGrane – Bureau of Reclamation

Jim Barton – Corps of Engineers

July 13, 2011

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Outline

- **Part I – Future Climate and Hydrology Datasets**
- **Part II –Reservoir Operations Assessment for Reclamation Tributaries**
- **Part III – Reservoir Operations Assessment**
  - **Columbia River Basin Flood Control**
  - **Hydrology Report**
- **Part IV – Summary Report**

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Schedule

- 2009 Collaborative process began
- 2010 Hydrology datasets selected
- Dec 2010 Part I Report - RMJOC
- Jan 2011 Part II Report - Reclamation
- June 2011 Part III Report - BPA and Corps
- August 2011 Summary Report - RMJOC

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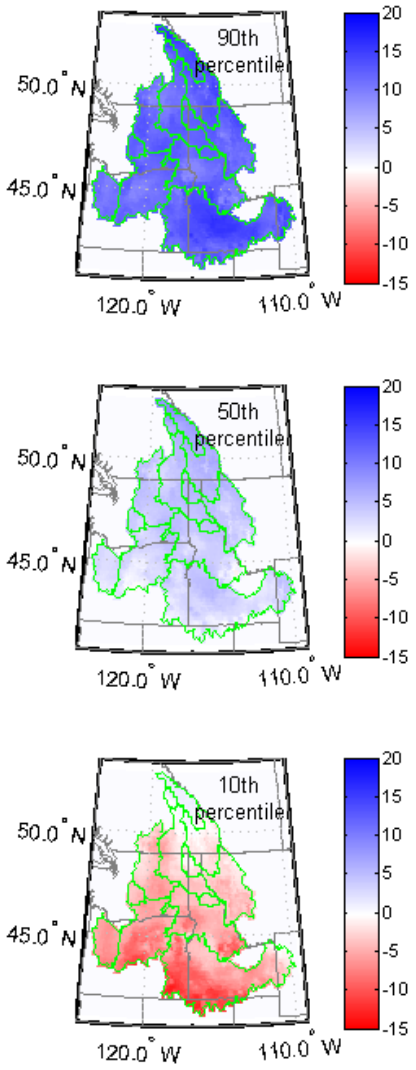

Projected change in mean annual precipitation (%) over the Columbia-Snake River Basin, from 1970-1999 to 2030-2059

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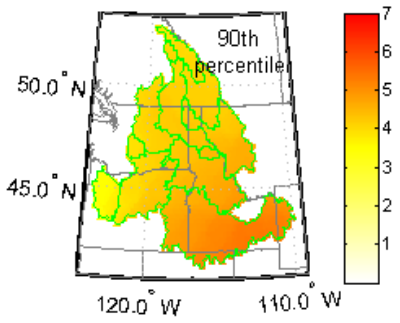

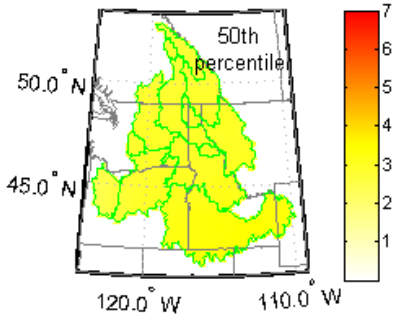

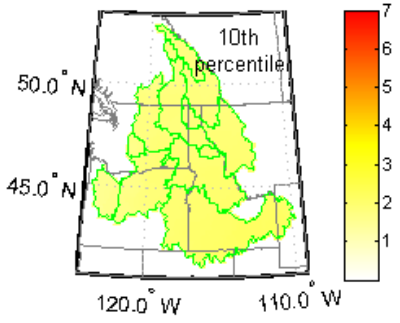

Projected change in mean annual temperature (ºF) over the Columbia-Snake River Basin, from 1970-1999 to 2030-2059

Collaborative Process

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UW CIG

Compiled GCM data, developed runoff models to produce future runoff (2020's, 2040's, and transient to year 2100). Funded by: WA Ecology, BPA, NWPPC, OR Dept WR, & BC Environment

Technical Team

Selected scenarios

Provided advice

Review

Collaborative Process

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Reclamation

- Produced future forecasts for all locations, used own reservoir models to simulate future tributary flows

Corps

- Computed future flood control space requirements based on perfect and imperfect runoff forecasts and current SRD's

BPA

- Ran Columbia River system power models with new data
- Compared Climate Change data to historic
- Wrote reports

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Part II – Reservoir Operations Assessment for Reclamation Tributary Basins

Yakima, Deschutes and Snake Rivers

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Part II – General Results

- Increased winter runoff, less spring/summer runoff
- Impacts on water supply not as great as anticipated
- Reclamation flood control curves self-adjusting
- Increased reliance on stored water vs. natural flow

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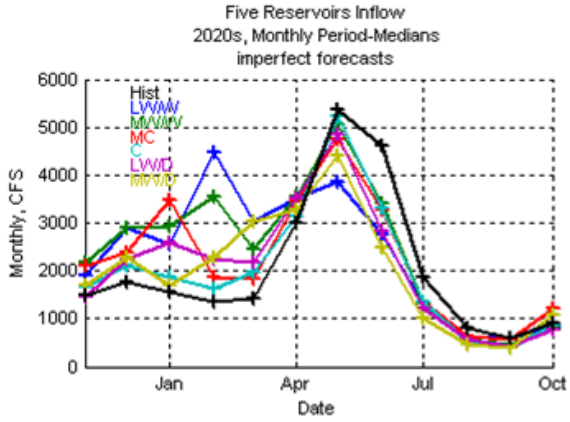
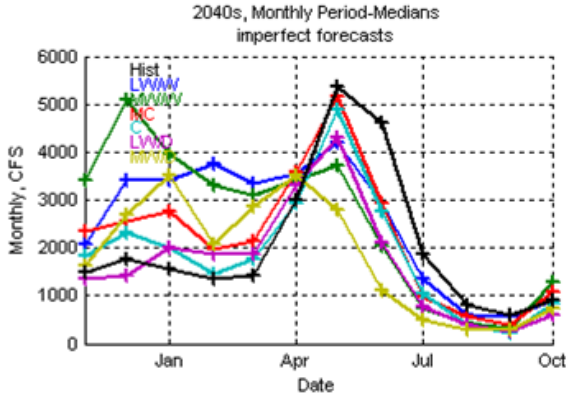
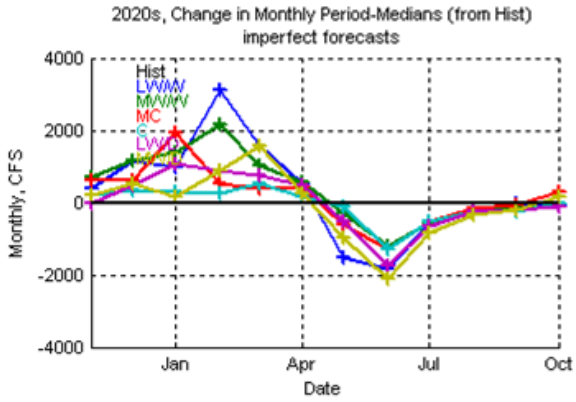
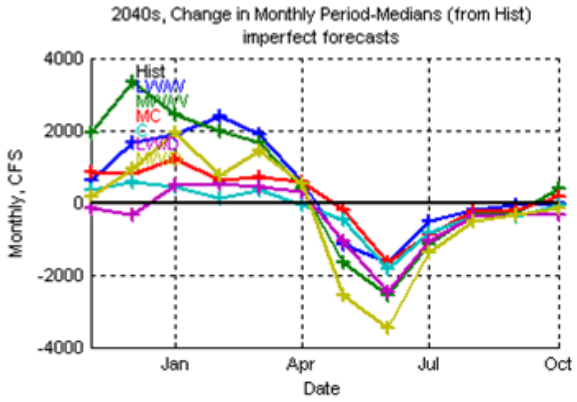
Part II: Yakima River – Flow Example









Familiar story:
Warming leads to more winter runoff, less spring-summer runoff; Rivers get lower in late summer.

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Part III Flood Control – Approach and Limitations

- Monthly time step and 70-year streamflow period rather than daily modeling due to time, data, and model limitations
- Assumed use of current flood control storage reservation diagrams & procedures rather than developing new diagrams/procedures in response to climate change
- Analysis focused on end-of-month flood control requirements during evacuation period and only estimated flood control requirements during the refill period

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Initial Findings and Implications for Flood Risk Management

1. Finding: Overall, climate change results show higher runoff variability in sub-basins across the region

   Implication: Overall distribution of flood control storage at different reservoirs may need to be revised, water management decisions may become more challenging

2. Finding: Many basins have generally higher fall/winter runoff, runoff shifted earlier in the spring, and lower runoff in the spring and summer

   Implication: Reservoir draft for flood risk management may need to draft to the deepest draft earlier.

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Initial Findings and Implications for Flood Risk Management, cont.

3. Finding: Winter rain and rain on snow events more likely, leading to less predictable reservoir inflows

   Implication: Some projects may need to be drafted deeper earlier in fall/winter season to respond to this unpredictability, draft rate limits may need to be revisited

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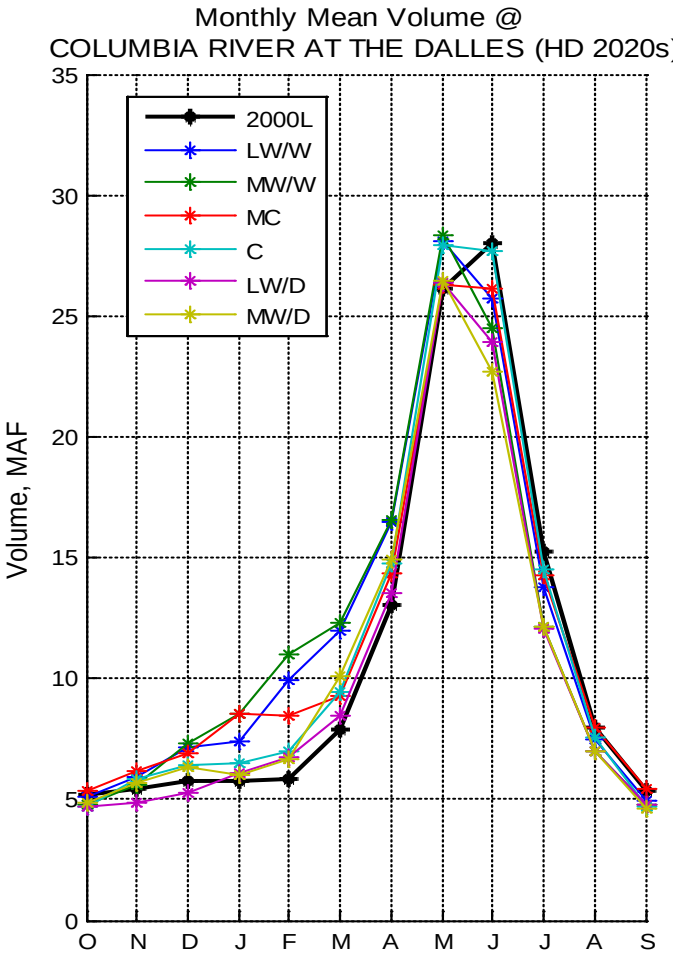
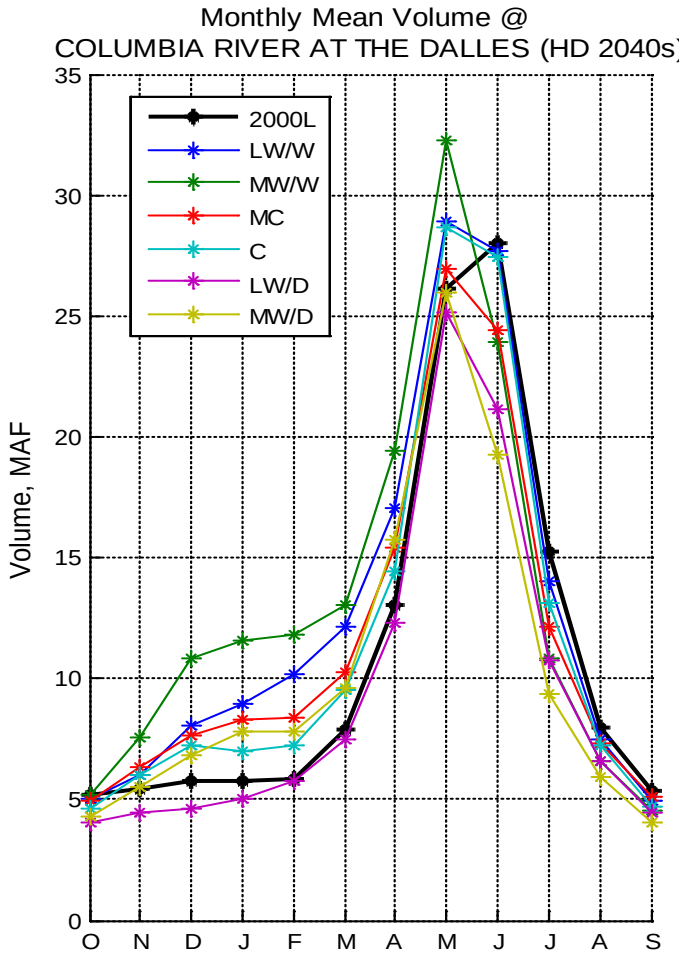
Summary of Basin-wide Results of Climate Change Data





More runoff volume from Jan-Mar

Peak month volume shift from Jun to May

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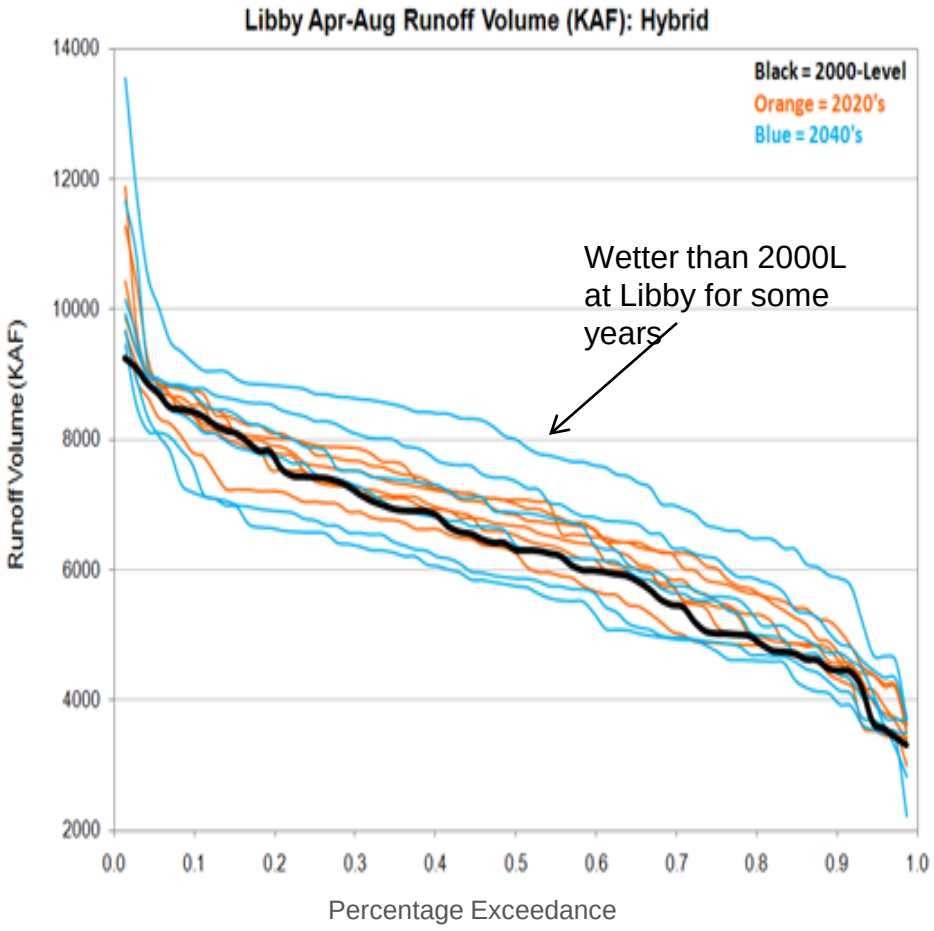
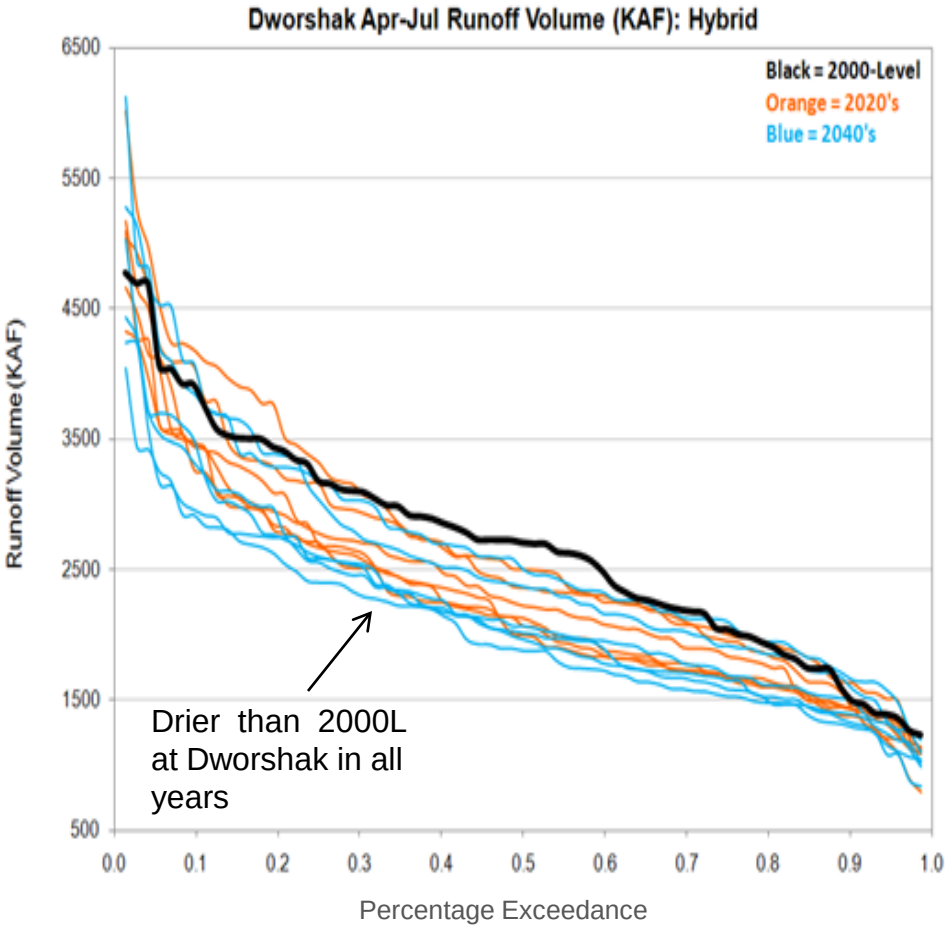
Summary of Results of Climate Change Data for Libby and Dworshak Reservoirs





Changes in hydrologic patterns in one basin are not necessarily the same as in another basin

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Part III Summary – BPA Analysis

Model Input: Natural Streamflows at The Dalles for 2020's & 2040's

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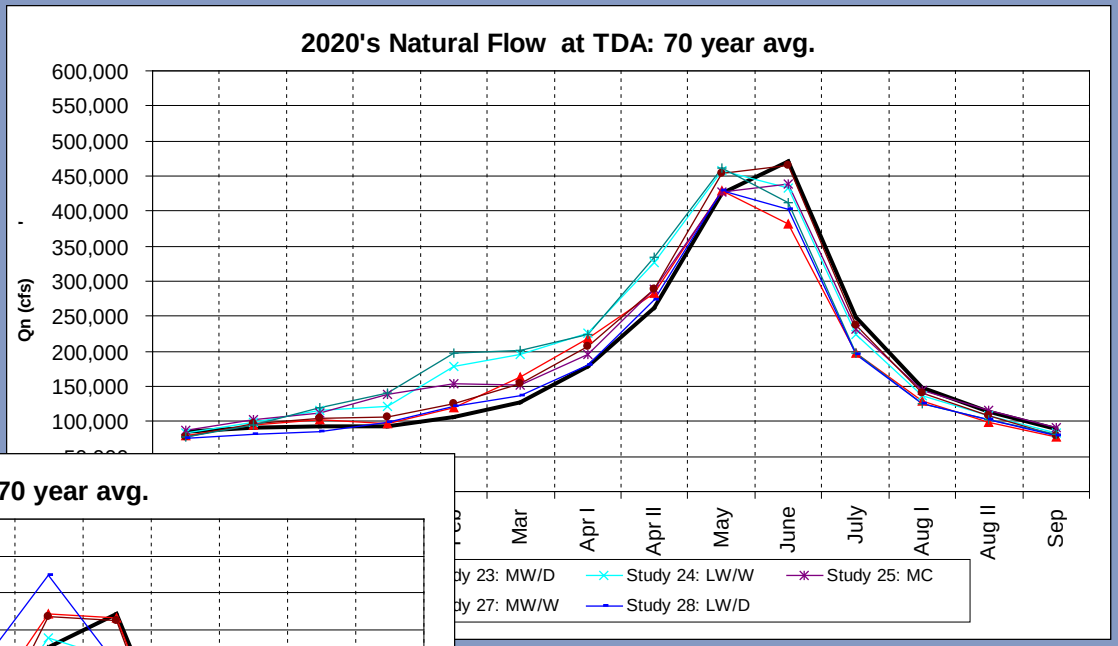
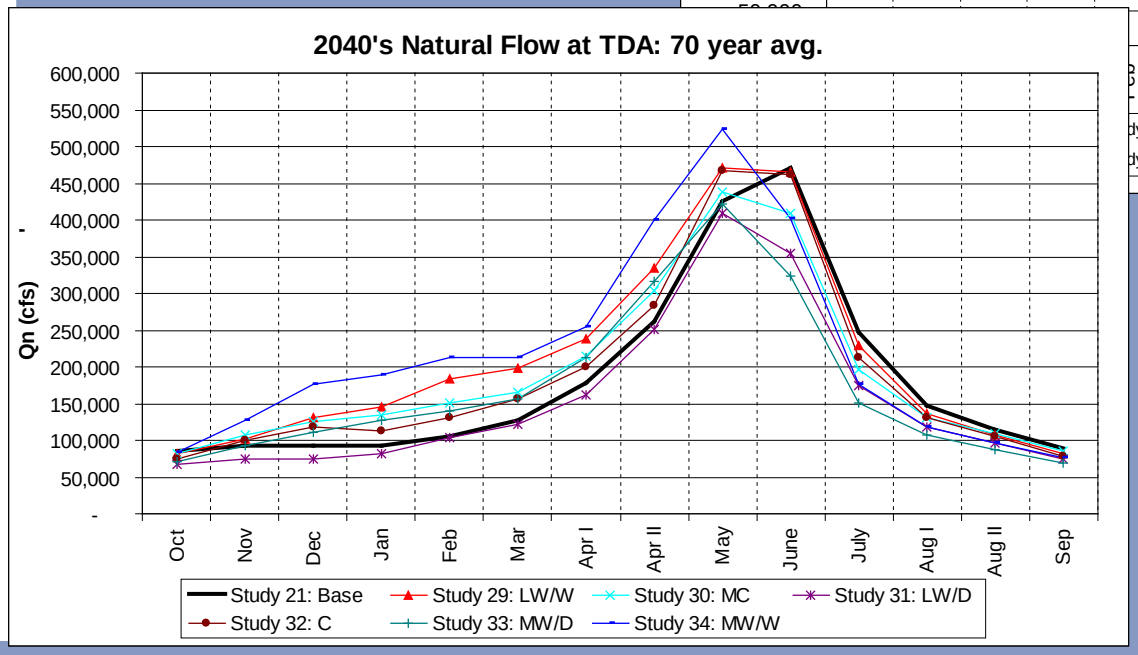
Climate Change scenarios result in higher natural streamflows in the winter to spring period…

and lower streamflows in the summer, generally speaking





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McNary Discharge Comparisons to Base Case

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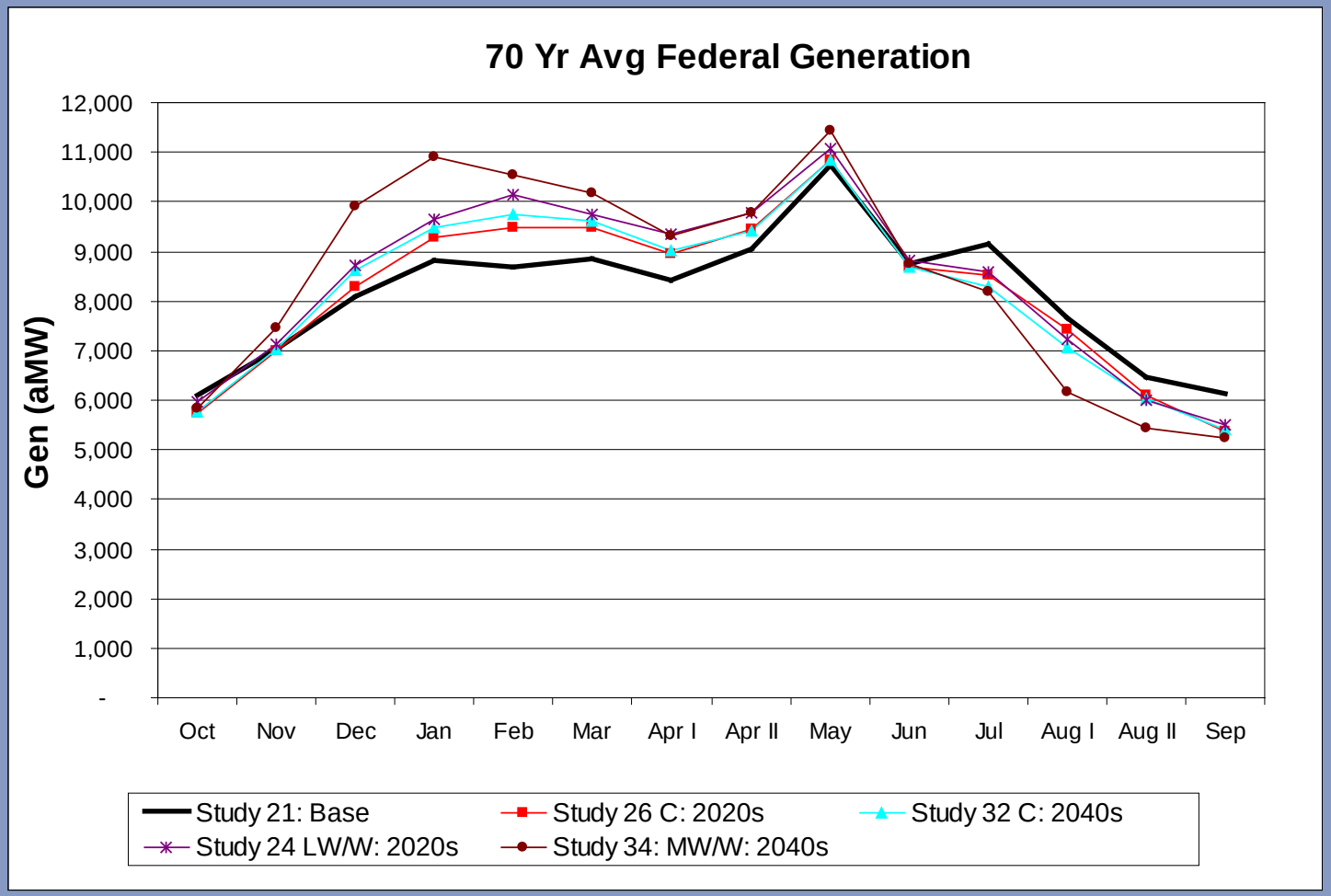
Federal Generation Comparisons for Two Central and Two Wet Scenarios



All four scenarios were modeled using the same load assumptions as the Base Case (2012 load projections)

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Next Steps
Short-Term < 10 Years

It is premature to include current climate change science in current operations. It is however, the time to start the conversation and plan for the future. Proposed actions include:

- Refining daily data to enable better analysis of flood risk.
- Conduct 2010 Modified Flow analysis (to be published this fall).
- Conduct backcasts (or use peer-reviewed backcasts already conducted) of temperature, streamflow, and seasonal streamflow ratios
- Establish criteria for when “change” warrants adjustments to current operations and planning processes (e.g. adopt climate change as the base case).
- Once IPCC’s 5th datasets are available (about 2013), identify and conduct new studies to update current, downscaled climate change scenarios.
- Coordinate and share climate change information with other Federal agencies and regional stakeholders.

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Next Steps
Long-Term Planning >10 Years

- Long-term planning processes will continue to use the 70 or 80 year modified streamflow record as the base case.
- Scenario analysis using the climate change data sets will be performed to look at the range of potential outcomes and to identify risks.
- Future long-term contracts and processes need to be flexible and adaptable to include actual climate information, especially when they span several decades.
- Some examples of future long-term planning processes that should have climate change analysis include.
  - Columbia River Treaty (2014/2024)
  - Corps Flood Control Studies
  - Future BiOps
  - NEPA processes that require hydro regulation studies
  - Asset Planning for Hydro Asset Strategy
  - Maintenance planning practices and guidelines
  - BPA's Resource Program
  - Reclamation storage studies

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Historic Temperature Information