Northwest **Power** and **Conservation** Council

September 4, 2024

MEMORANDUM

TO: **Council Members**

FROM: **Kris Homel, Kate Self, Leslie Bach, and Patty O'Toole**

SUBJECT: **Fish and Wildlife Program performance: hydrosystem categorical assessment**

BACKGROUND:

Presenters: Kris Homel, Kate Self, Leslie Bach, and Patty O'Toole

Summary: Current staff and contracted support staff will present excerpts from the first categorical assessment focused on implementation of the Columbia River Basin Fish and Wildlife Program's (Program) hydrosystem measures. This assessment covers major hydrosystem actions called for in the Program over the last 40 years and implementation of those actions, relative to any identified benchmarks (e.g., targets for seasonal flows). The presentation will begin with a review of Program strategies and performance indicators associated with hydrosystem measures. Next, we will describe implementation of a subset of measures selected from the hydrosystem assessment to characterize the range of actions implemented throughout the basin. These high-level examples will be described with an emphasis on discussion points rather than technical details. We will conclude with a discussion of Program-scale observations from these examples, particularly related to prioritization, adaptive management, challenges, and improvements over time. This assessment, along with other upcoming categorical assessments, will provide critical information to the Council and region on the implementation and

performance of the Program in anticipation of the upcoming Program amendment.

Relevance: Beginning with the first Program in 1982, every fish and wildlife Program has included references to aspects of Program performance. The 2020 Program addendum addresses Program performance through (1) reorganizing and compiling Program goals and objectives and (2) developing strategy performance indicators. Council staff are assessing Program performance through three complementary efforts: the first is the Program Retrospective (presentations in 2022 and 2023), the second is assessments of implementation by major category of work (Categorical Assessments), and the third is an evaluation of progress toward reaching Program Goals and Objectives.

Workplan: Item 4.1 Program Performance- Hydrosystem Categorical Assessment

Background: The Northwest Power and Conservation Council's Columbia River Basin Fish and Wildlife Program represents a 40-year effort to mitigate the effects of the hydropower system on fish and wildlife in the Columbia Basin. The scope of and investment in this Program make it one of the largest fish and wildlife mitigation efforts in the world and a significant part of the tapestry of mitigation efforts in the Columbia Basin. There is limited precedent for assessing the performance of a program of this size. Given this scale, we developed an overall approach to manage the volume and complexity of information.

The performance assessment includes three complementary efforts- the Program Retrospective, assessments of Program implementation by major category of work (Categorical Assessments), and an evaluation of progress toward Program Goals and Objectives.

In 2024, staff released a retrospective of the Northwest Power and Conservation Council's Fish and Wildlife Program that included a review of the Program's history and key events. This historical context provided information on why different elements have been included in the Program over time, what kind of changes were expected to occur, where those changes could occur, and when they could occur. In preparing this retrospective, we went through a detailed process to assemble the full set of measures called for across 40 years of Programs. These were organized by topic so that we could determine how the Program has changed over time and when different topics came to prominence, along with identifying major topics in each Program. Staff presented on the Retrospective in 2022 and 2023 and it was a one-time review of past Programs.

The categorical assessments provide more detailed information on implementation of the major topics identified in the retrospective. These

are organized according to four main *categories* in the Program: Hydrosystem, Habitat, Artificial production, and Program Adaptive Management. For 2024, we will present a summary of the first three categories. In each assessment, we describe (1) what was called for in the Program, (2) what was implemented, and (3) how implementation compares to available benchmarks. These assessments incorporate content from existing summaries (e.g., the Program Tracker with Strategy Performance Indicators, published research or reports, and dashboards on particular topics) and also include new summaries from a variety of information sources. Strategy Performance Indicators are updated annually on Program Tracker, and categorical assessments will be updated prior to Program amendments, approximately every five years.

The third piece of program performance is evaluating progress toward the goals and objectives described in the 2020 addendum. The status and trends of these goals and objectives will be presented in December 2024 and will be available on the Council's expanded Program Tracker web tool at that time. Evaluating progress relies on multiple sources of data, including the SPIs. Goals and objectives will be updated annually on Program Tracker.

In this inaugural hydrosystem categorical assessment, over 40 Program actions were reviewed following the approach described above. Staff met with individual regional managers who were topical experts on these actions to better understand the context around implementation. Those discussions led to the development of key topics for the region to consider. For this presentation, we selected a subset of actions implemented throughout the basin. Examples include flows for migrating salmon and steelhead, passage for lamprey, tailwater elevations for mainstem spawners, and instream and reservoir operations for resident fish. Implementation of these actions will be described at a high level with an emphasis on discussion points rather than technical details. This discussion will include a summary of how adaptive management, hydrosystem priorities, and environmental conditions (including climate change) have influenced implementation of these operations, and where challenges are being addressed. We will conclude with a discussion of Program-scale observations from these examples.

Staff will release supplementary documentation on the hydrosystem assessment prior to the call for recommendations to amend the Fish and Wildlife Program. The staff considers this work to be iterative and welcomes feedback even as this particular category of work wraps up for 2024 in order to assess implementation of other categories before the start of the amendment process. In future years, assessments will build off the framework developed this year and will include additional measures, expanded documentation, and further opportunities for feedback. Collectively, the retrospective, categorical assessments, and status and trends assessment will provide critical information to the Council and

region on the Fish and Wildlife Program and serve as an educational resource leading up to the next Program amendment.

More Info: Highlights from the Hydrosystem assessment were presented to the Council in October 2023. The slides and presentation are available here:

https://www.nwcouncil.org/fs/18487/2023_10_f4.pdf
https://vimeo.com/874878458#t=143m59s

The full presentations on the Program Retrospective were delivered to the Fish and Wildlife Committee in 2022 and the full Council in 2023. Those presentations are available here:

August 2022: https://www.nwcouncil.org/fs/17876/2022_08_f1.pdf
September 2022: https://www.nwcouncil.org/fs/18031/2022_09_f2.pdf
May 2023: https://www.nwcouncil.org/fs/18305/2023_05_1.pdf

The retrospective is available on the Council's website here:
https://www.nwcouncil.org/fs/18802/retrospective.pdf

Fish and Wildlife Program performance: Hydrosystem categorical assessment

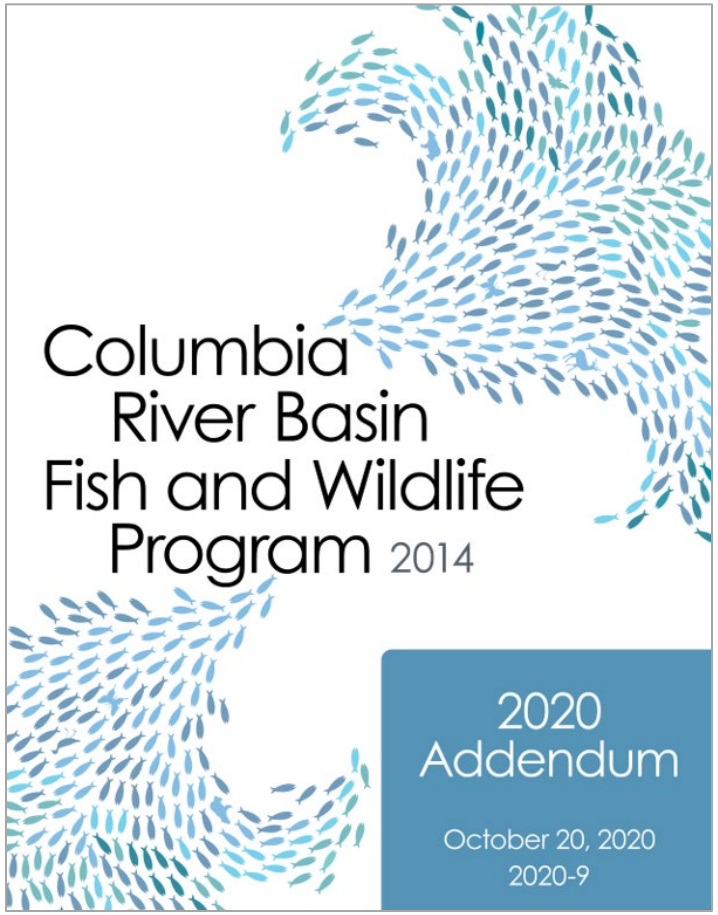
Kris Homel, Kate Self, Leslie Bach, Patty O'Toole

Council Meeting
September 2024

Northwest **Power** and **Conservation** Council

Evaluating performance of the Fish and Wildlife Program

- Called for in the Northwest Power Act
- Aspects of performance in every program
- Recent increased focus on understanding progress from 40 years of investment across the Columbia Basin
- Program performance evaluation is an educational resource: Identify key questions for region to consider in anticipation of next Program amendment



The Fish and Wildlife Program includes:

- **Measures to be implemented**
  - At the dams
  - Offsite (in mainstem/ tributaries/ estuary/ ocean)

  Implemented by action agencies, Council, and through projects
- **Measures are organized by strategy**
  - 23 Program strategies
- **<u>Goals and objectives</u>**
  - 5 goals, 37 objectives

Protection and mitigation for all Fish and Wildlife affected by the hydrosystem, not just listed species

Outline

- Approach to Program Performance
- Components of Hydrosystem Categorical Assessment
- Description of select operations relative to Program measures
- Discussion

Outline

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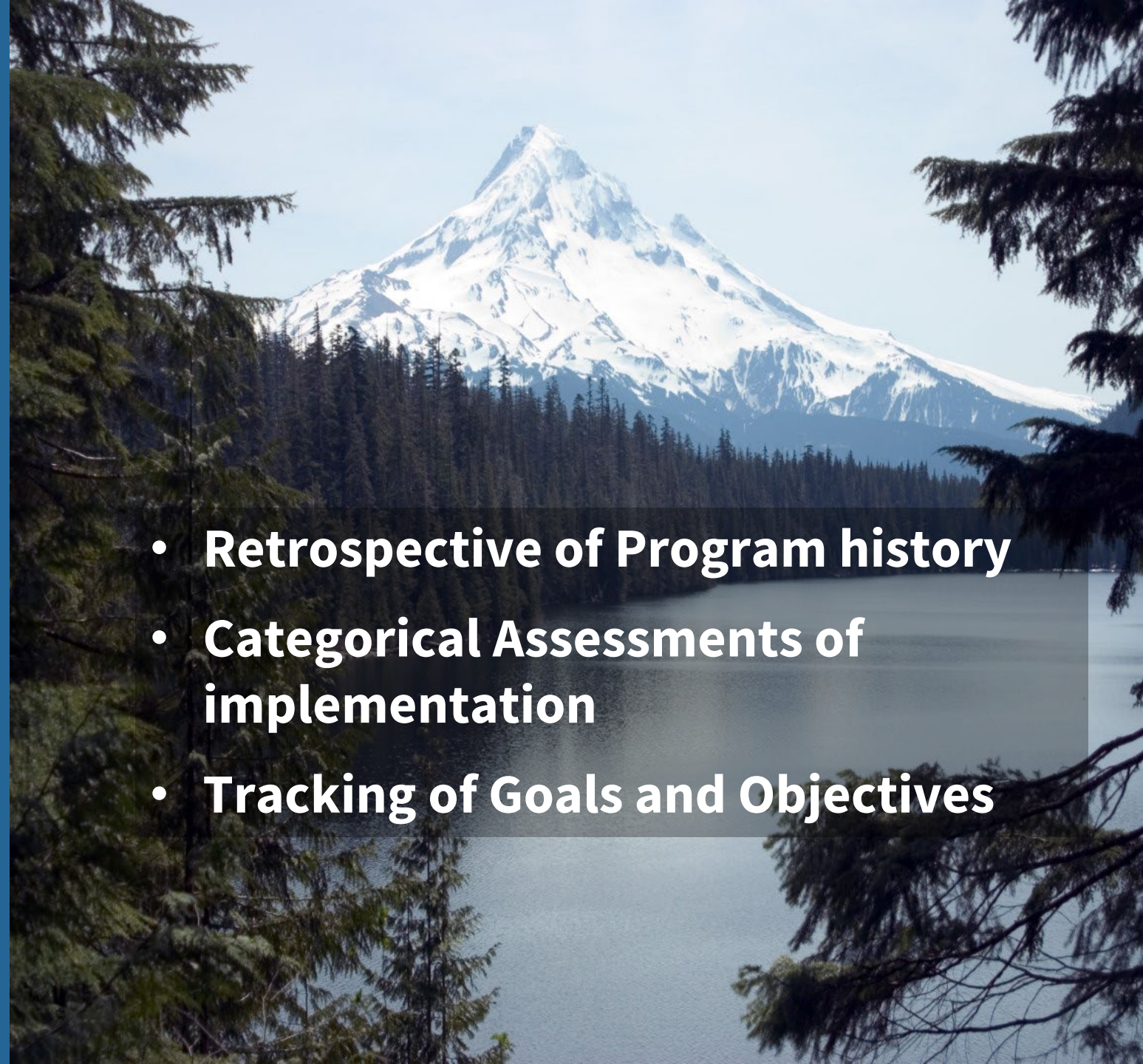


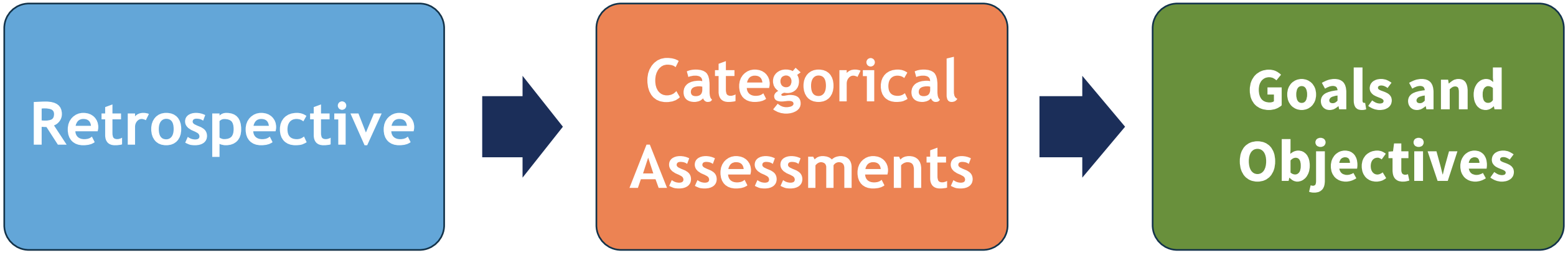
- **Retrospective of Program history**
- **Categorical Assessments of implementation**
- **Tracking of Goals and Objectives**

Our approach…

One-time document

Updated every five years

Tracker updated annually



Program history and context

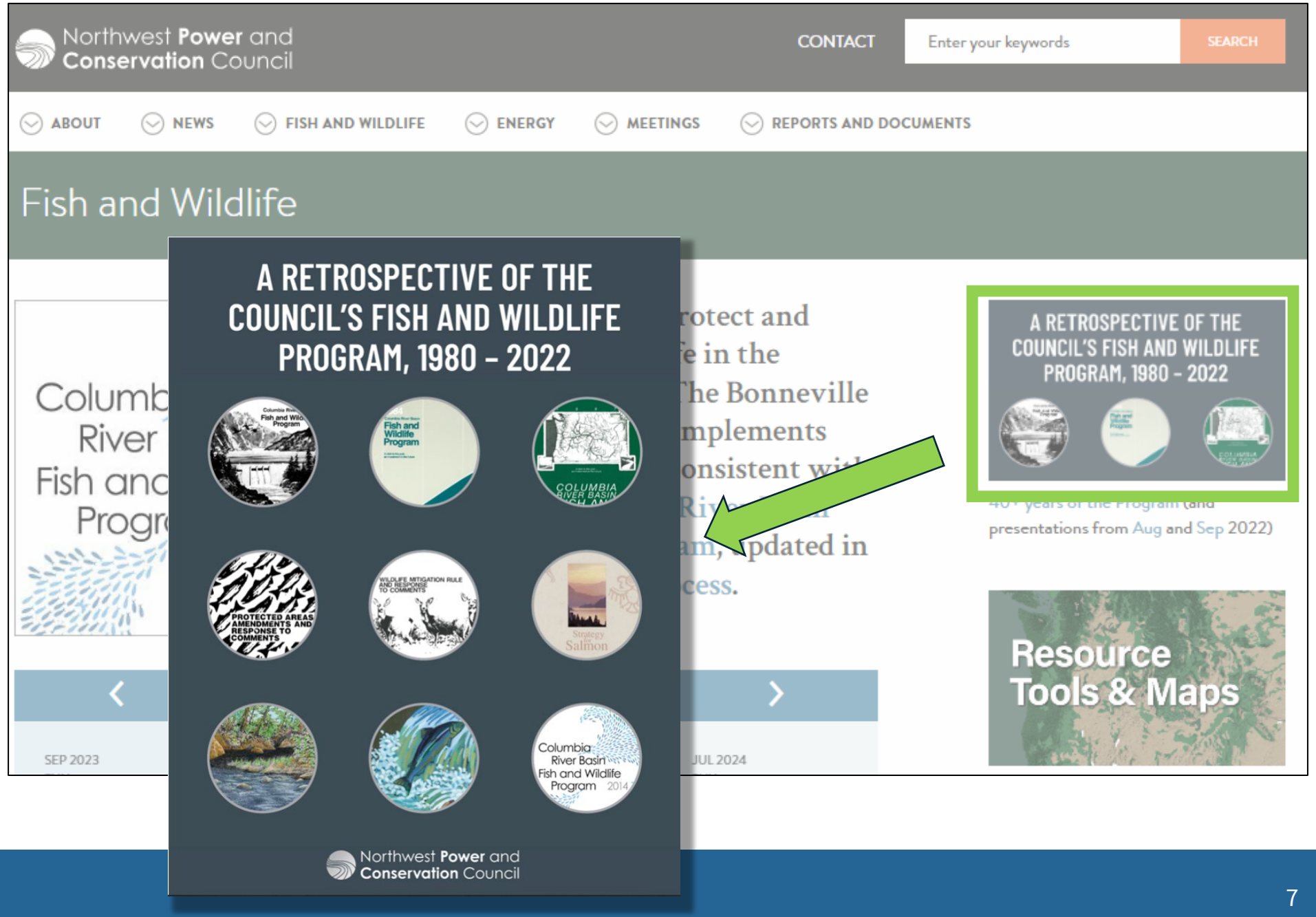
Describe Program implementation; uses SPIs (updated annually)

Status and trends

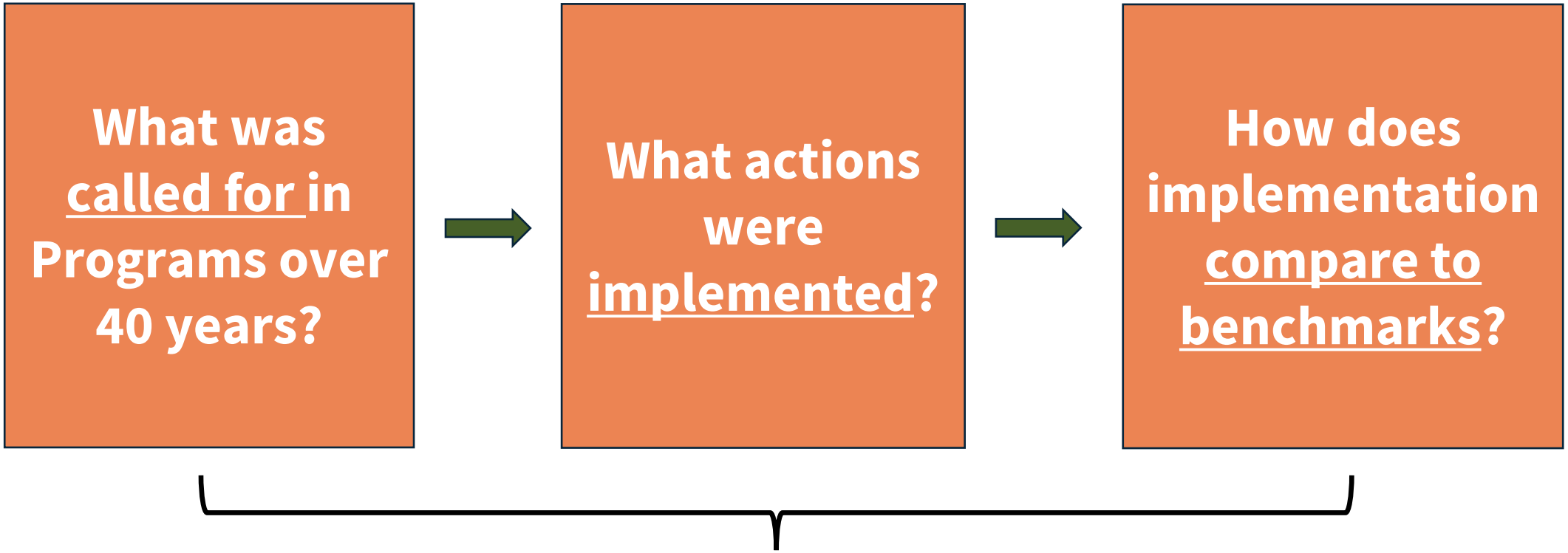
Retrospective

- **Identify major actions**

- Development of Basin and Hydropower
- Northwest Power Act
- Program history and context by decade



Categorical assessment steps



- Report on implementation, progress, challenges
- Identify key questions for region to consider

Goals and objectives

Track progress toward Program goals and objectives from 2020 addendum

- 5 Goals
- 37 Objectives
- Associated SPIs

- Revising Program Tracker to include goals and objectives
- Each goal and objective has high level visual summary and is connected to associated SPIs
- All methods to summarize data documented on Tracker
- December presentation on progress toward goals and objectives

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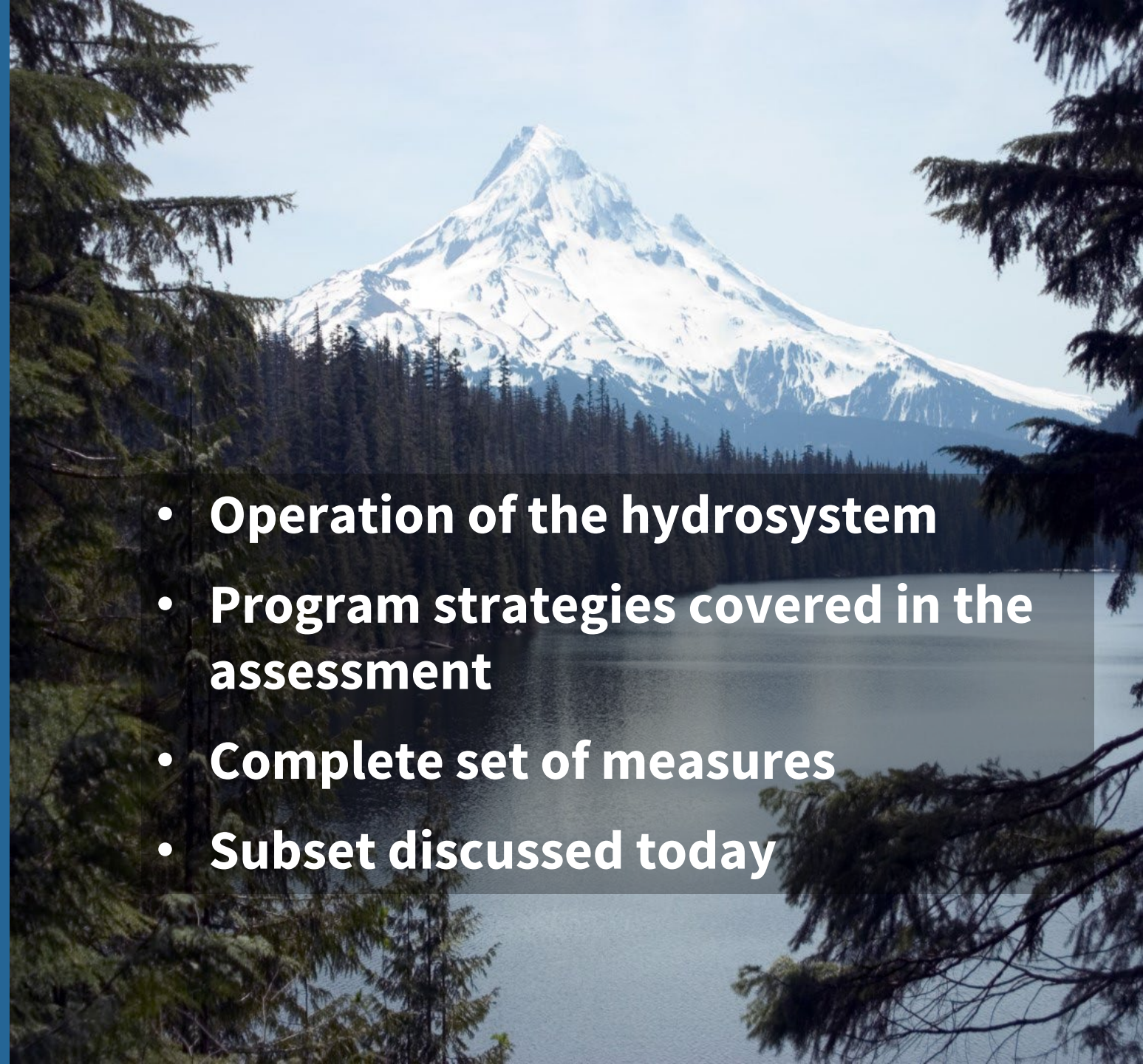


- **Operation of the hydrosystem**
- **Program strategies covered in the assessment**
- **Complete set of measures**
- **Subset discussed today**

Key Points

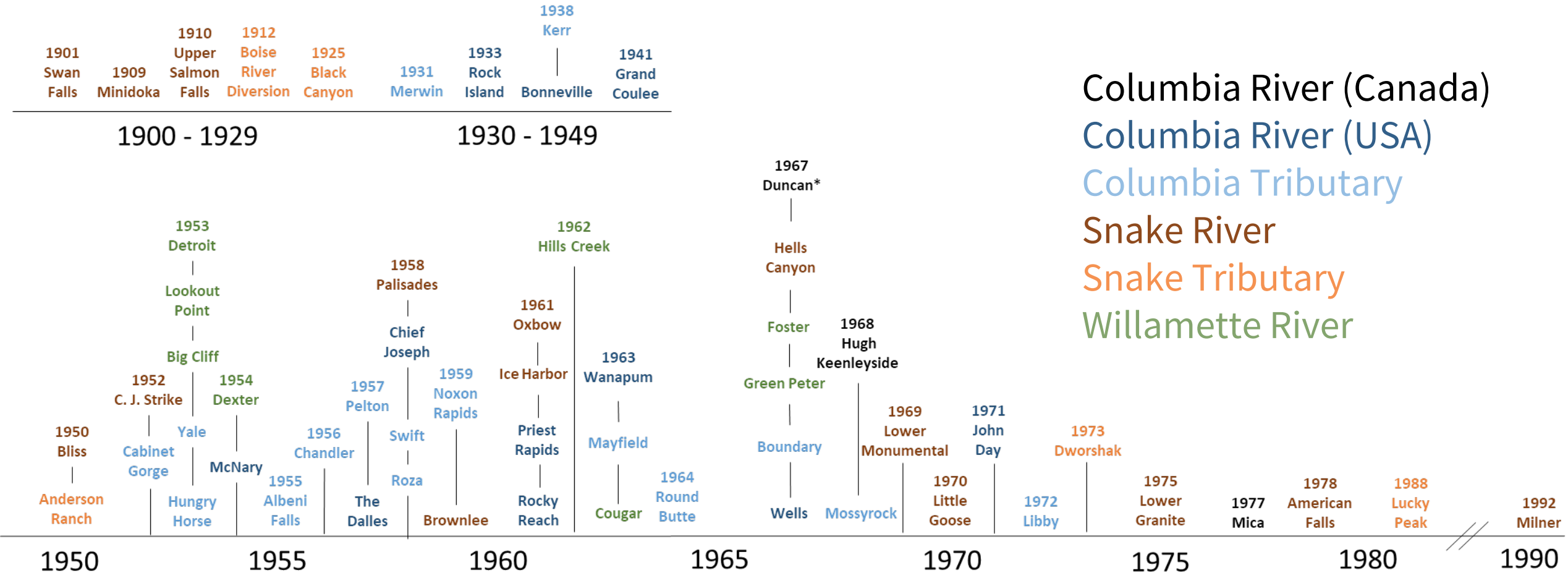
Themes:

- Adaptive management
- Variable implementation
- Challenges in implementation
- Improvements over the past 40 years

What do we need to think about leading up to the next amendment?

As the priorities or conditions of the Basin change, are operations adaptable?

Development of the hydrosystem

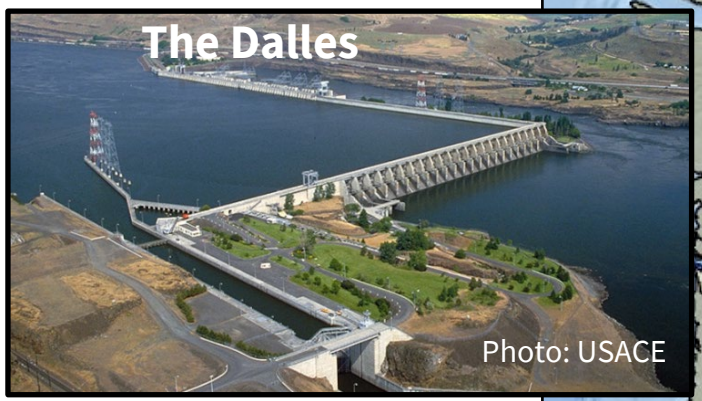


Columbia River (Canada)
Columbia River (USA)
Columbia Tributary
Snake River
Snake Tributary
Willamette River

Dams listed in year construction finished and power generation began unless power retrofit to existing dam. *Dam operated for storage only.


Grand Coulee
Photo: USBR


Hungry Horse
Photo: USBR


The Dalles
Photo: USACE


Little Goose
Photo: USACE


Detroit
Photo: USACE


Anderson Ranch
Photo: USBR

Mica
Revelstoke
Duncan
Keenleyside
Boundary
Albeni Falls
Libby
Chief Joseph
Grand Coulee
Wells
Cabinet Gorge
Noxon Rapids
Kerr
Rocky Reach
Rock Island
Wanapum
Little Goose
Lower Granite
Roza
Priest Rapids
Mayfield
Mossyrock
Cowlitz Falls
Dworshak
Swift
Chandler
Ice Harbor
John Day
McNary
Merwin
Yale
Bonneville
The Dalles
Hells Canyon
Oxbow
Big Cliff
Detroit
Brownlee
Green Peter
Pelton Round Butte
Black Canyon
Foster
Cougar
Lucky peak
Dexter
Hills Creek
Lookout Point
Boise River Diversion
Anderson Ranch
Upper Salmon Falls
American Falls
Swan Falls
Bliss
C J Strike
Minidoka
Milner

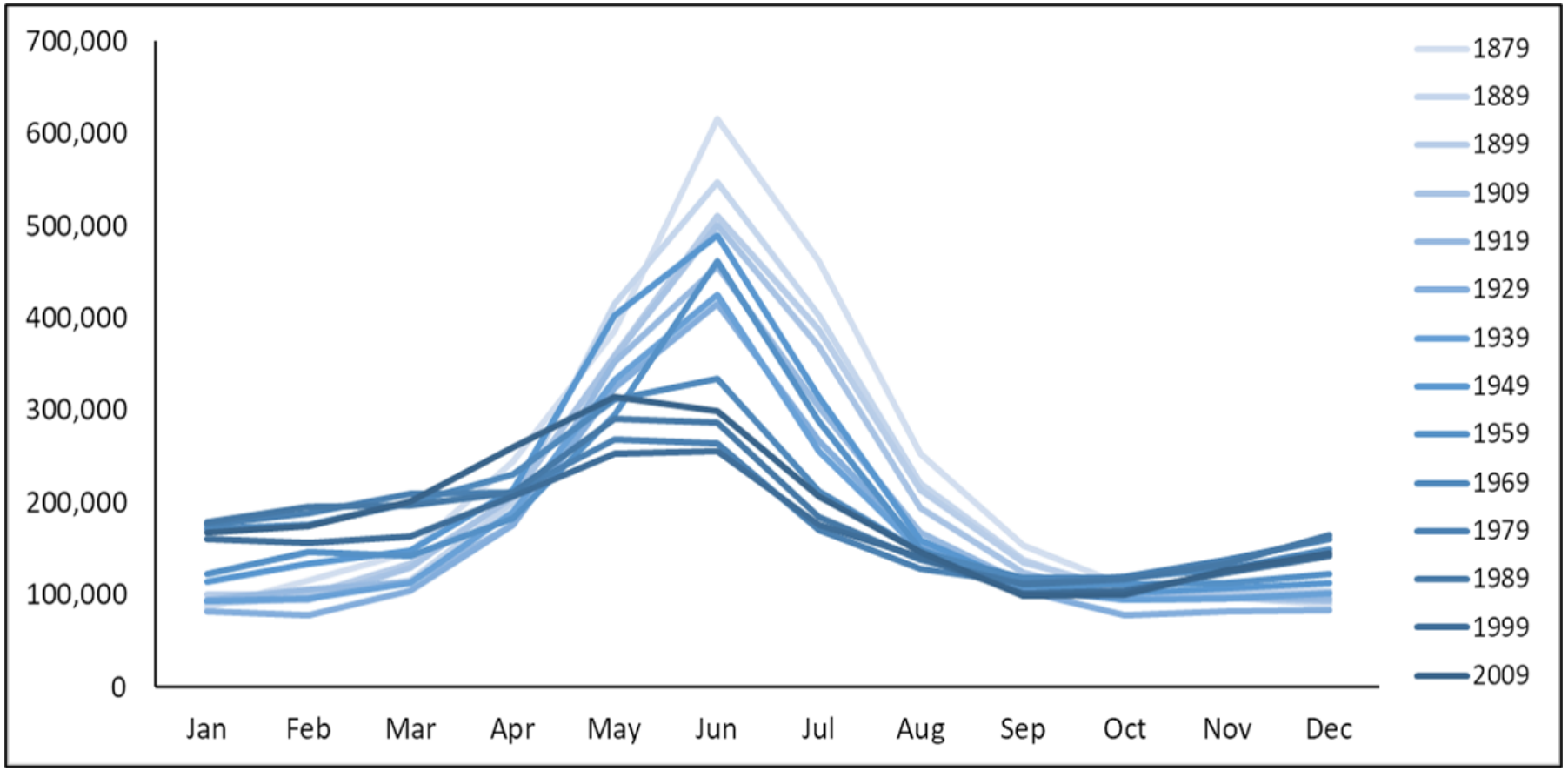
Hydrosystem effects on fish and wildlife

System wide effects

- Altered hydrograph
- Habitat fragmentation
- Food web effects
- and more

Losses

- Salmon, steelhead
- Other anadromous fish
- Resident fish
- Wildlife



Average monthly discharge (CFS) at The Dalles Dam, by decade.
Year labels for each line represent the beginning of the decade.

Hydrosystem operations

- Management of the hydrosystem requires designing operations at multiple locations to meet:
  - Different authorizing purposes
  - Fish requirements
  - System needs
- Power planning integrates fish operations as a firm constraint
  - Integrated after other critical operations like flood management, structural limits to flow and reservoir elevation, etc.
- Implementing individual fish operations not always feasible given environmental conditions (seasonal precipitation, timing of runoff)

Program strategy: ecosystem function

Protect and restore natural ecosystem functions, habitats, and biological diversity wherever feasible consistent with biological objectives in the program.

Measures:

- Manage water, where feasible, to approximate natural flow timing and reduce large, rapid, short-term fluctuations.
- Manage water temperature to approximate natural conditions using stored water.
- Evaluate and mitigate for impacts to ecosystem function in estuary and plume resulting from actions in mainstem.

Program strategy: water quality

Provide flows and habitat conditions of adequate quality and quantity for improved survival of anadromous and native resident fish populations on the mainstem Columbia and Snake rivers, as well as improving water quality in Basin tributaries, to promote healthy and productive populations of anadromous and native resident fish and wildlife.

Measures:

- Monitor and report on TDG and water temperature at dams
- Develop fish passage strategies that produce less TDG
- Improve temperature and TDG modeling to support real-time operations
- Monitor, report, and address toxics released from dams (e.g., oil spills)

Program strategy: mainstem hydrosystem flow and passage

Manage dams and reservoir operations to protect and restore ecosystem function and habitat, and to improve fish passage and survival through the hydrosystem.

Analyze the power system effects of operations for fish and recommend adaptations to the power system so that these operations may be delivered in a reliable manner while the region continues to have an adequate, economic and reliable power supply.

- General measures for listed (consistent with BiOp) and unlisted species.
- Specific measures:
  - Hanford Reach, Libby, Hungry Horse, Albeni Falls, Grand Coulee, Hells Canyon
  - Improve passage, spill, flow, ecosystem function and connectivity, etc.

Program strategy: resident fish mitigation

For resident fish and other aquatic species impacted by the hydrosystem, protect and mitigate freshwater and associated terrestrial habitat, and native fish populations.

Measures:

- Support efforts to address all limiting factors…including impacts from ongoing operation of the hydrosystem.
- Restore passage for resident fish where feasible, including at Albeni Falls Dam.

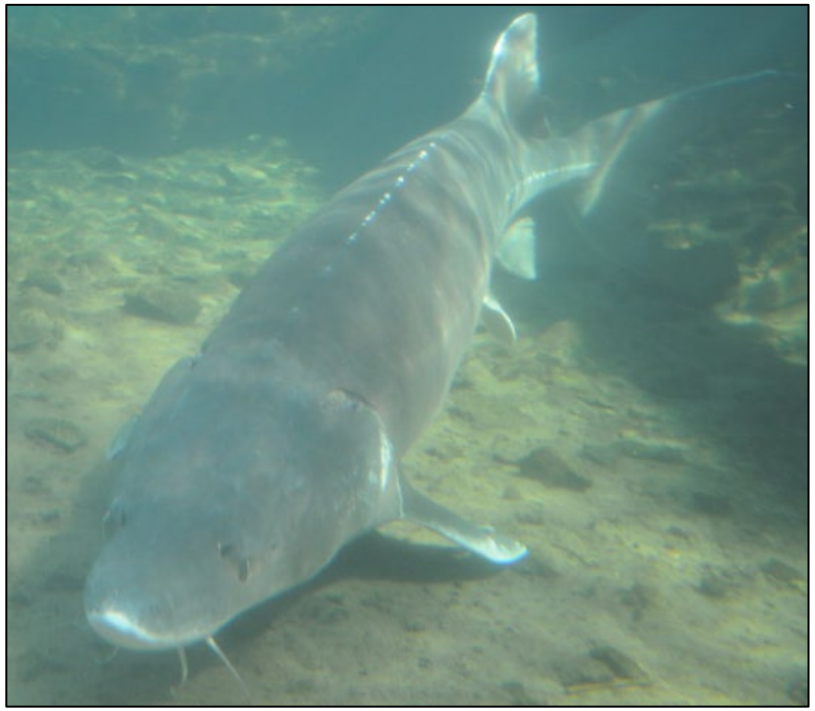
Photo by Trout Unlimited

Program strategy: sturgeon

Implement actions that result in increased abundance and survival for Columbia River Basin green and white sturgeon, including habitat actions, dam operations and passage, hatchery considerations, monitoring populations, and research to improve understanding of how the development and operation of the Federal Columbia River Power System affect survival and growth of sturgeon.

Measures:

- Provide beneficial flows
- Balance hydrosystem operations for anadromous and resident fish
- Passage
- Research and monitoring
- Prevent entrainment

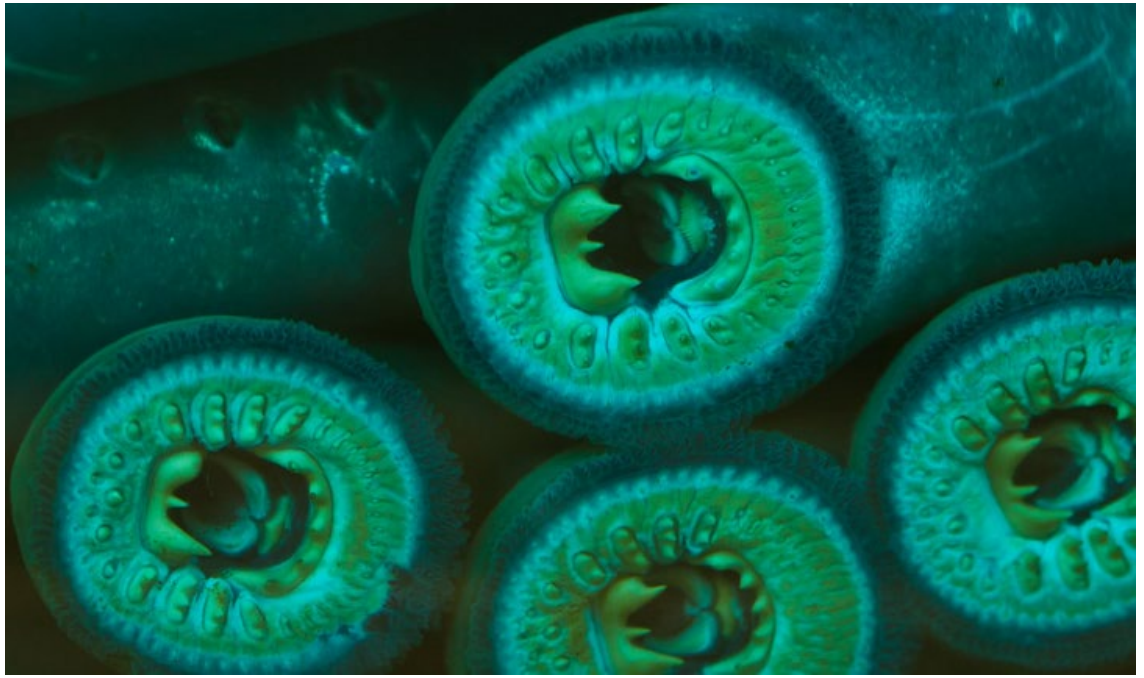


Program strategy: lamprey

Implement actions that result in increased abundance and survival for lamprey, including habitat actions, dam operations and passage, monitoring populations, and research to improve understanding of how the development and operation of the Federal Columbia River Power System affect migration success, survival and growth of lamprey.

Measures:

- Research effect of hydro operations on lamprey
- Monitor passage at mainstem dams
- Establish passage standards
- Install lamprey passage structures
- Monitor predation on lamprey during passage



Program strategy: eulachon

Increase understanding, protection, and required restoration of eulachon for the Columbia Basin, estuary, and ocean ecosystems. Better understand how the development and operation of the Federal Columbia River Power System (FCRPS) affects eulachon spawning, survival of eggs and larvae, and migration patterns.

Measures:

- Hold a science-policy forum to address biological requirements of Eulachon.
- Research how requirements are affected by flow and hydro operations.

Purpose of hydrosystem measures is to improve:

Juvenile migration (salmon and steelhead)

Adult migration (anadromous fish)

Mainstem spawning and rearing (salmon)

Resident fish (by location)

Salmon/ Steelhead

- Water budget and seasonal flows
- Upper Snake River flow augmentation
- Passage
- Spill
- Transportation

Juvenile Migration

Salmon/Steelhead

- Summer flows
- Temperature management
- Passage structures and operations

Lamprey

- Passage
- General measures

Adult Migration

Hanford Reach Fall Chinook

- Seasonal flow
- Stable flow

Chum Salmon below Bonneville

- Seasonal flow

Mainstem spawning and rearing

Columbia/ Snake River (Sturgeon)

- Flow and temperature
- Passage

Libby and Hungry Horse- downstream

- Minimum flow
- Sturgeon pulse
- Seasonal flows
- Ramp rates
- TDG
- Temperature

Libby and Hungry Horse- reservoir

- Reservoir drawdown
- Reservoir refill
- Stable reservoir elevation
- Reservoir end of summer draft

Grand Coulee

- Reservoir refill and stable elevations
- Fall draft limits for kokanee
- Water retention time

Albeni Falls/ Pend Oreille

- Reservoir refill
- Reservoir drawdown
- Passage

Resident fish, by location

Juvenile Migration

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- Passage

Considerations

- Interconnectedness of the Columbia River hydrosystem
- Differences in priorities throughout the basin
- Changes in implementation over time
- Emerging issues
  - Changing precipitation and temperature regimes
  - Changes in species composition
  - Stressors on the system

David Jensen Photography

Outline

- Approach to Program Performance
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Salmon/ Steelhead

- Water budget and seasonal flows
- Upper Snake River flow augmentation
- Passage
- Spill
- Transportation

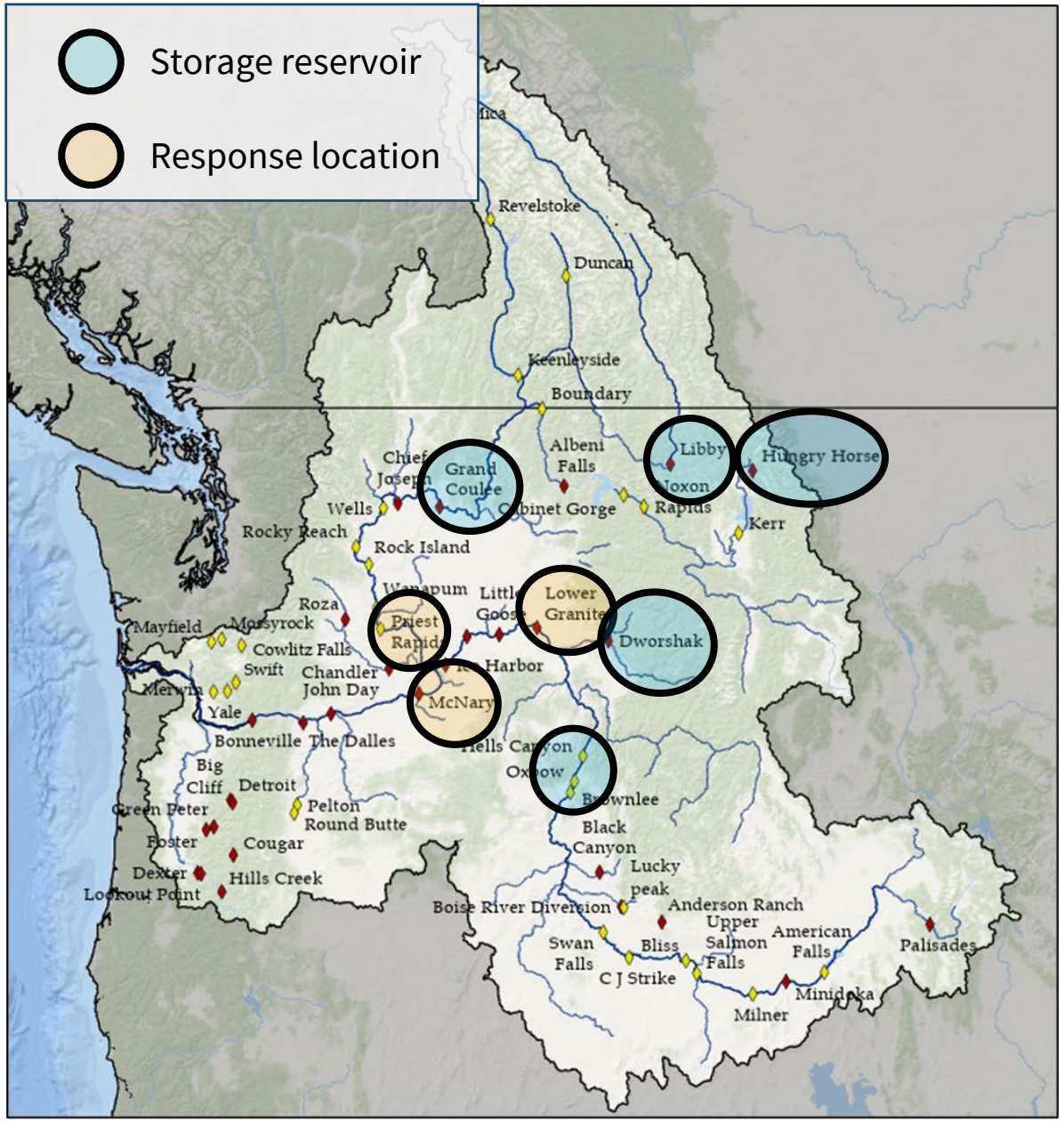
Juvenile Migration

Program action summary:

Improve migration conditions and survival through augmenting seasonal flows, managing reservoir elevations to speed migration, implementing seasonal spill, installing passage structures, and transporting fish seasonally.

Water budget and seasonal flows

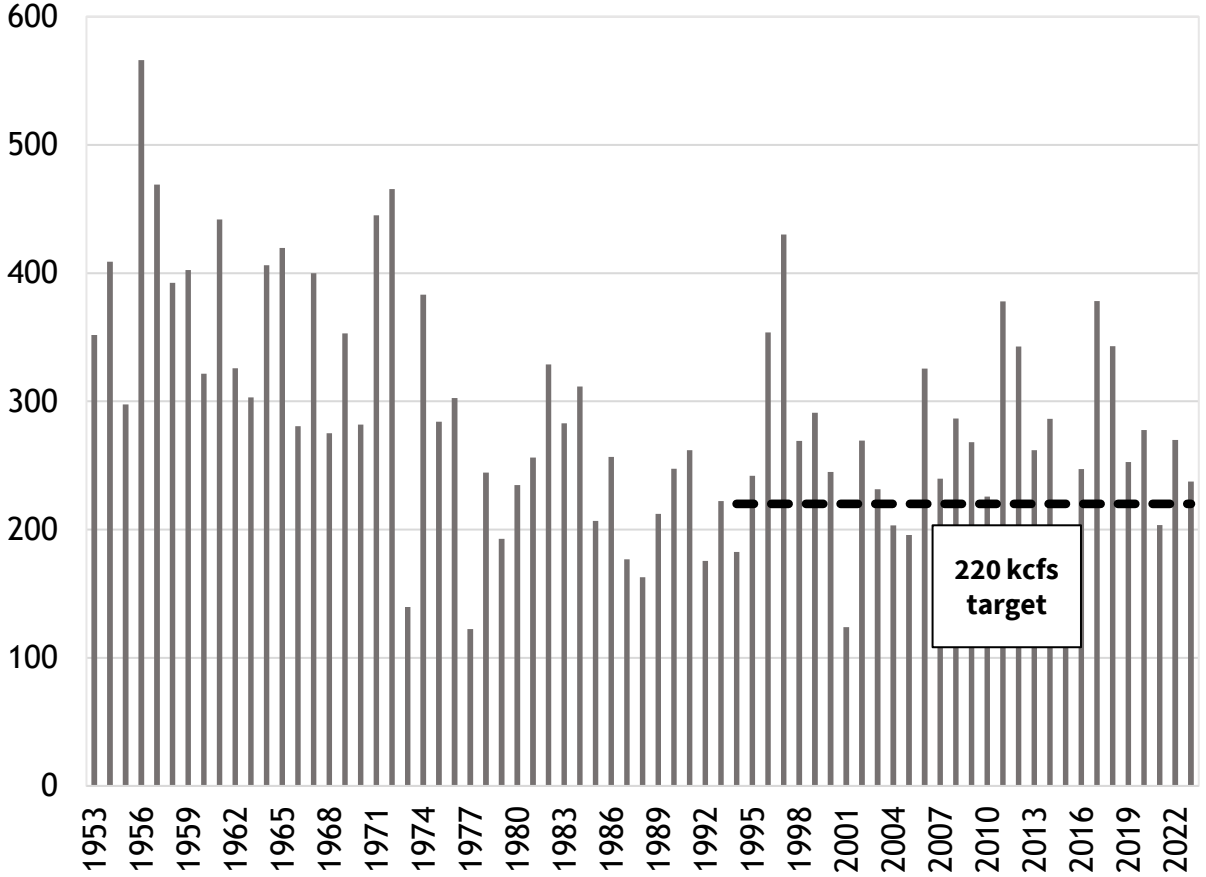
1980's Council	**NPCC Fish and Wildlife Program Water Budget**
'92-'95 Council	**Average monthly flow equivalents**
'94-'98 BiOps	**Seasonal average flow target ranges**
2000 – Present Council/ BiOp	Continued **seasonal average flow target ranges or targets** • Lower Granite (85-100 kcfs) • McNary (220-260 kcfs) • Priest Rapids target set at 135 kcfs



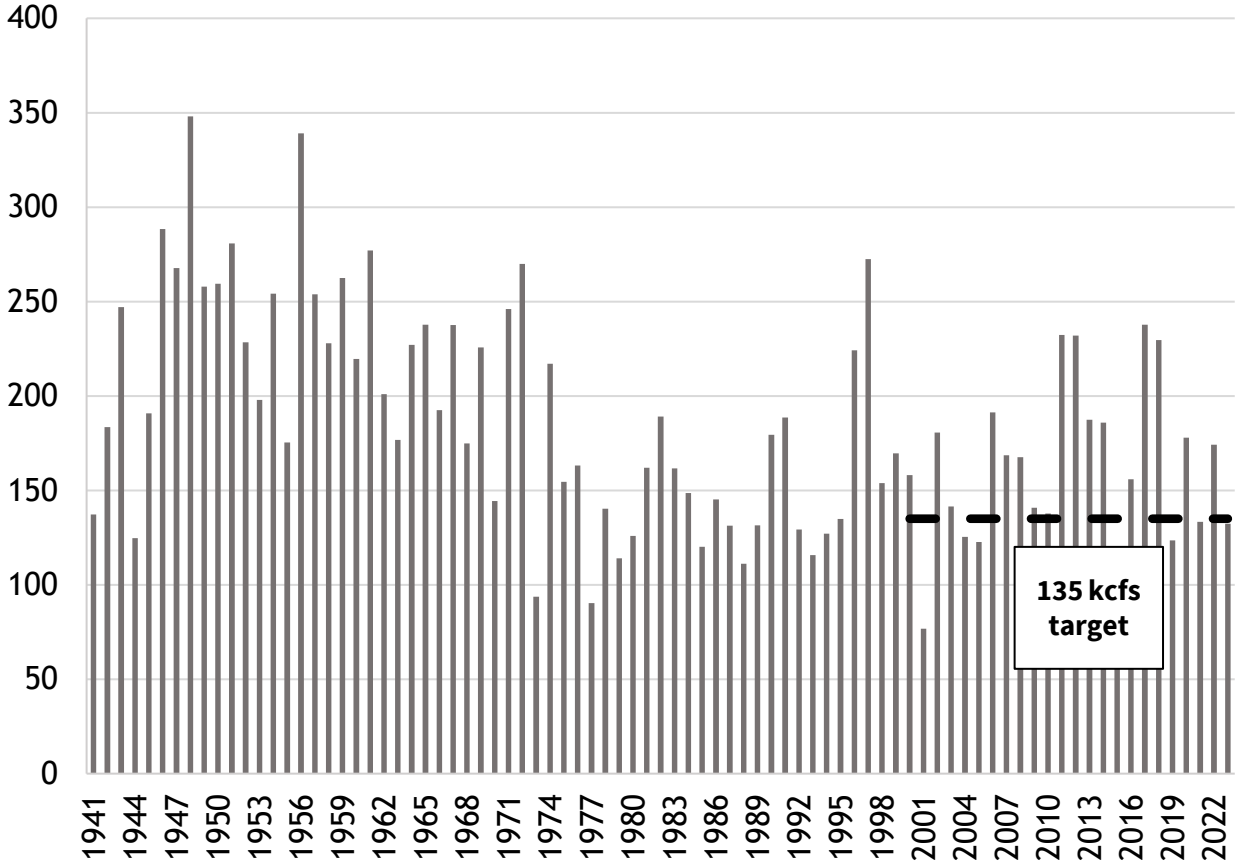
Location of major dams (diamonds; red = federally owned, yellow =publicly or privately owned) in the Columbia River Basin. Map created in ArcGIS Pro (C) 2020 ESRI.

Spring Season at McNary and Priest Rapids Dams

Average annual spring flow at McNary Dam



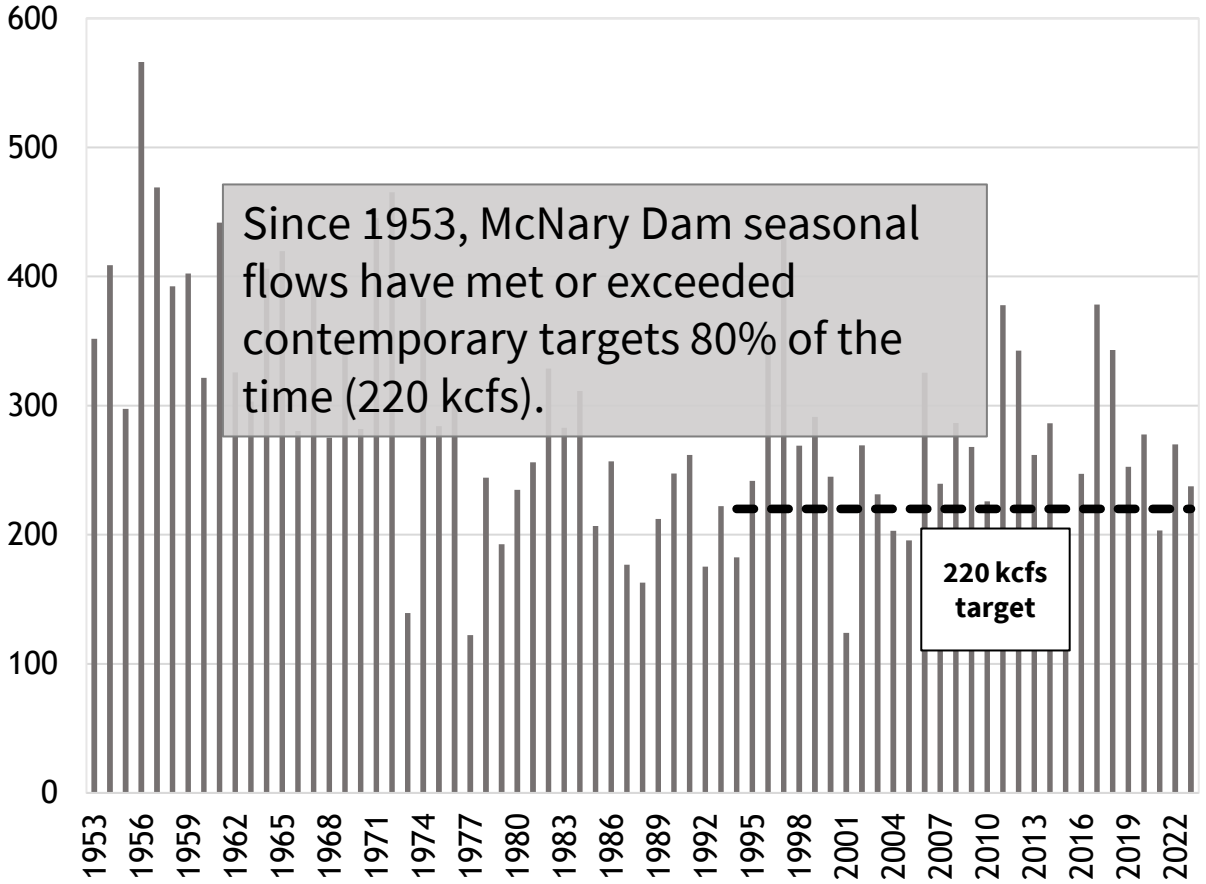
Average annual spring flow at Priest Rapids Dam



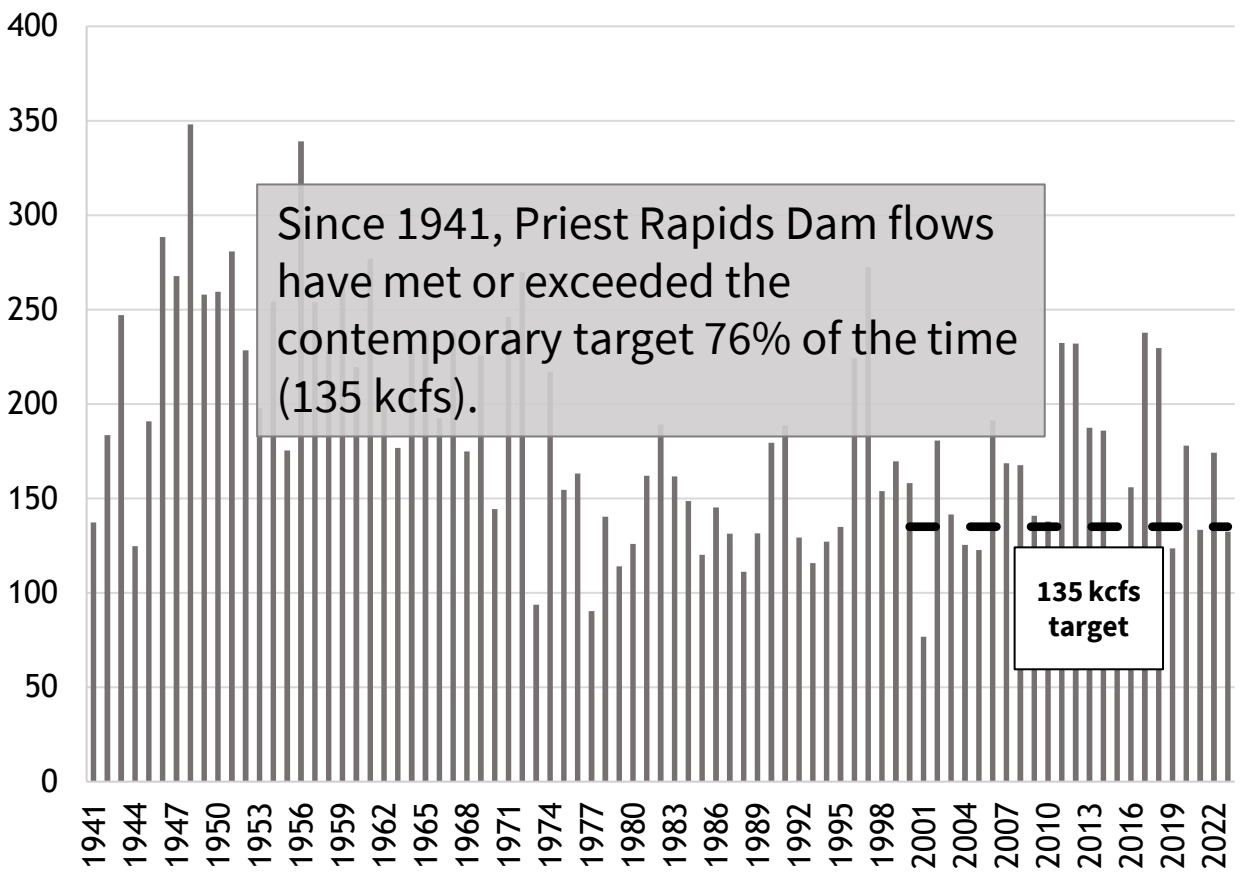
Note: Contemporary flow data and targets available on Program Tracker, SPI E3-1

Spring Season at McNary and Priest Rapids Dams

Average annual spring flow at McNary Dam



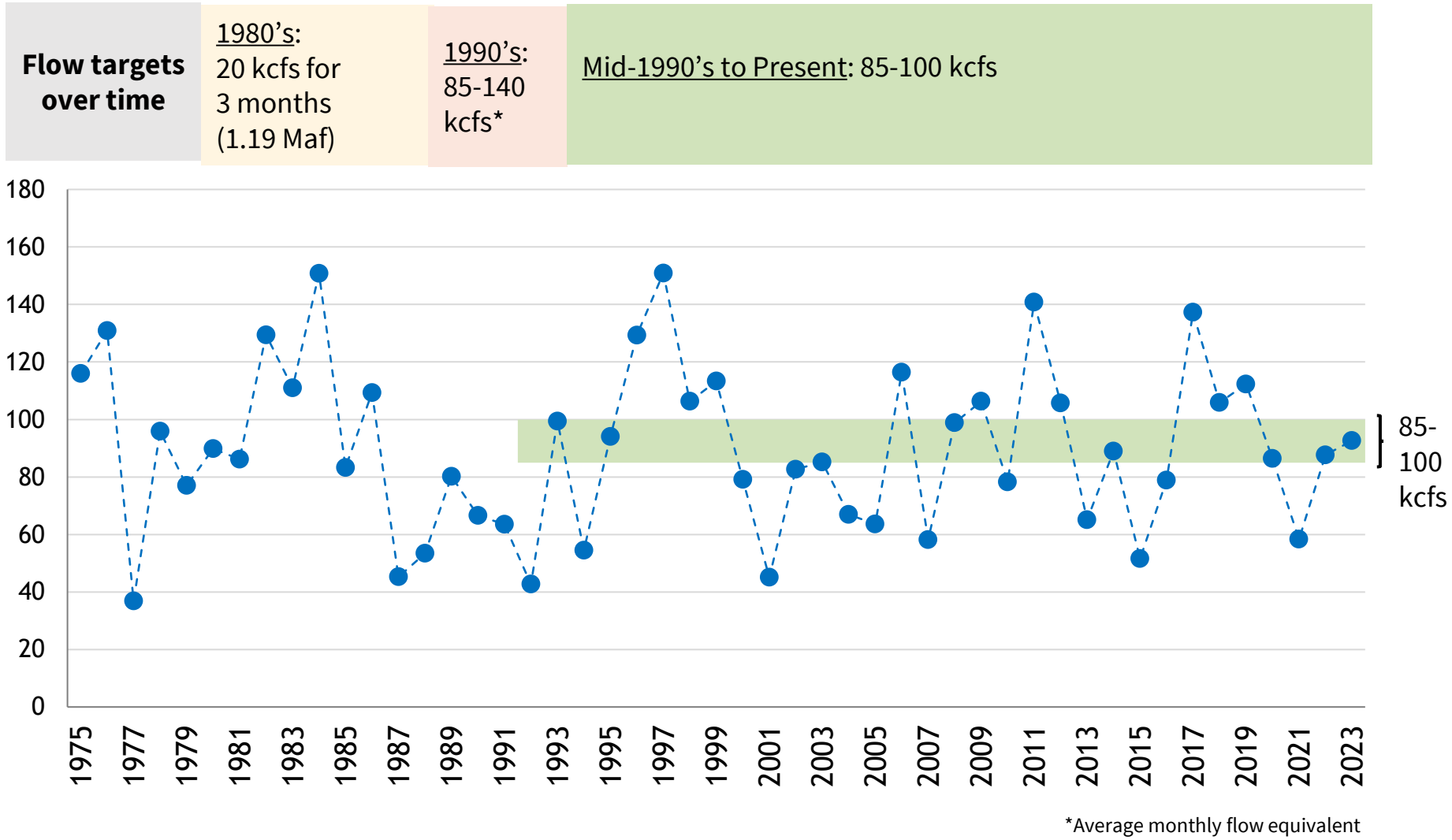
Average annual spring flow at Priest Rapids Dam



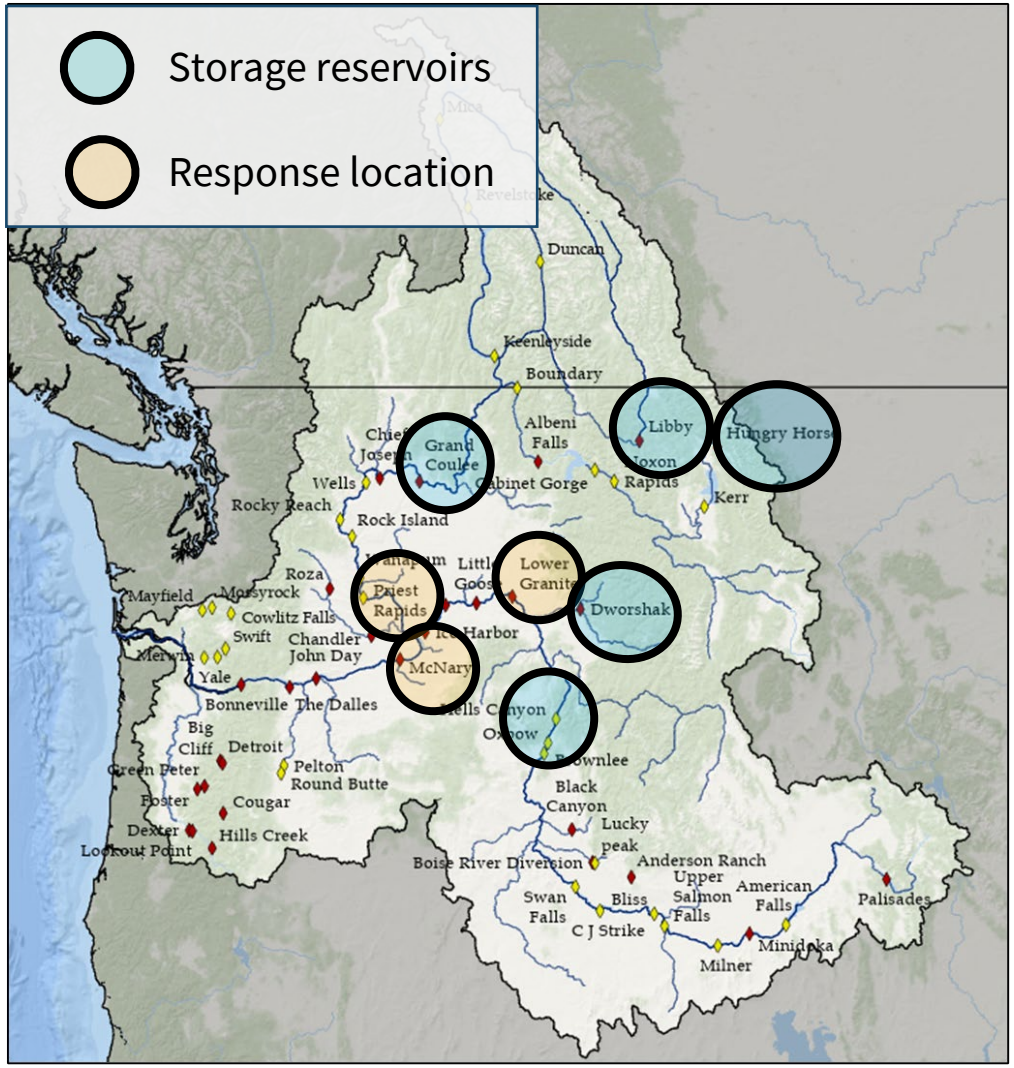
Note: Contemporary flow data and targets available on Program Tracker, SPI E3-1

Spring season at Lower Granite Dam

- The minimum target flow of 85 kcfs has been met 57% of the time since 1975 and 61% of the time since 1995.
- There is less capacity to regulate flows in season at Lower Granite Dam than at Priest Rapids Dam or McNary.



*Average monthly flow equivalent



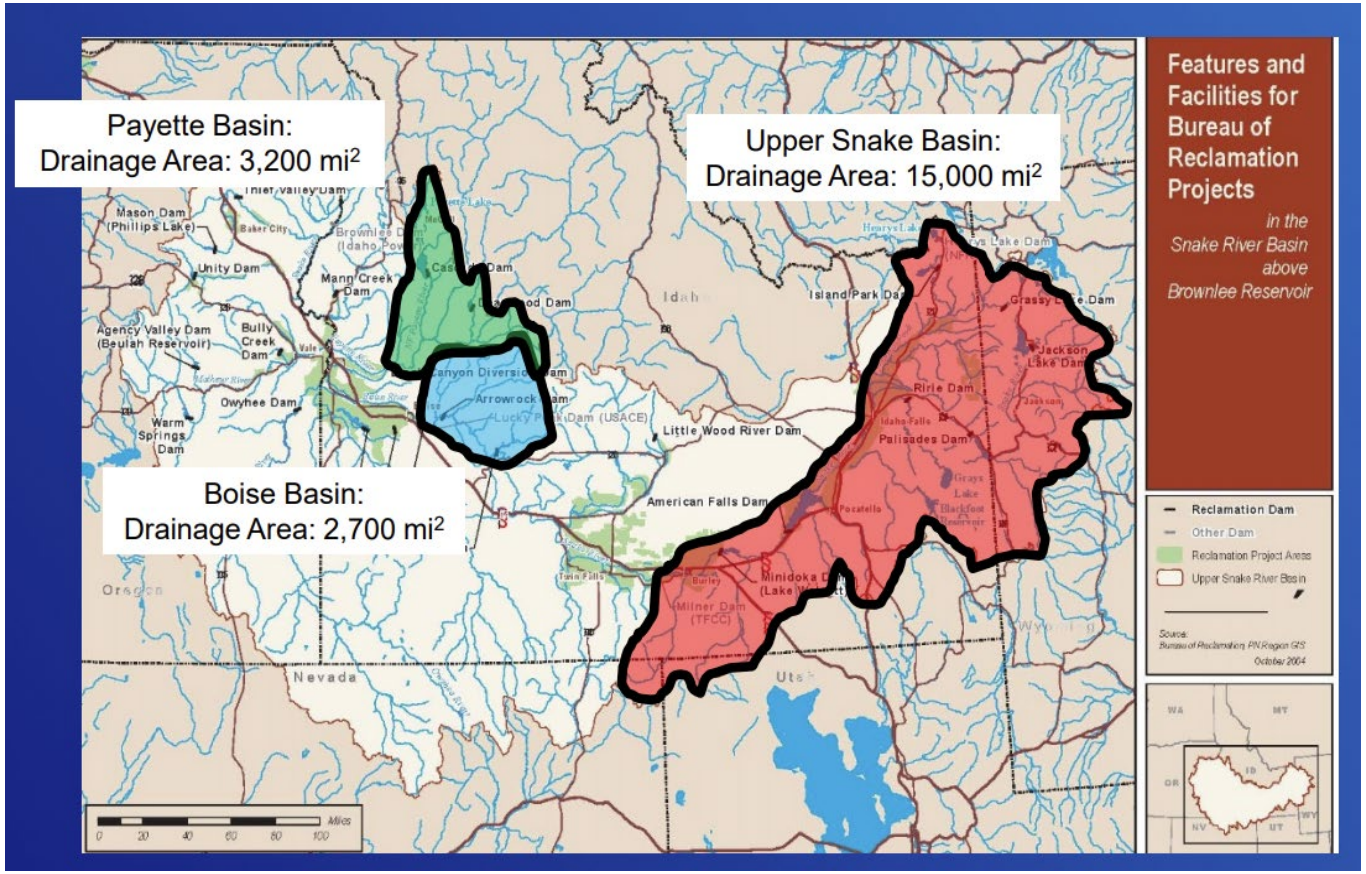
Location of major dams (diamonds; red = federally owned, yellow = publicly or privately owned) in the Columbia River Basin. Map created in ArcGIS Pro (C) 2020 ESRI. All rights reserved.

Summary of juvenile migration results

- Seasonal flow targets are driven by annual precipitation.
- McNary and Priest Rapids Dams often meet or exceed spring target flows.
- Lower Granite Dam meets or exceeds target flows less often.
- Managers use **adaptive in-season management** to work within annual water constraints.

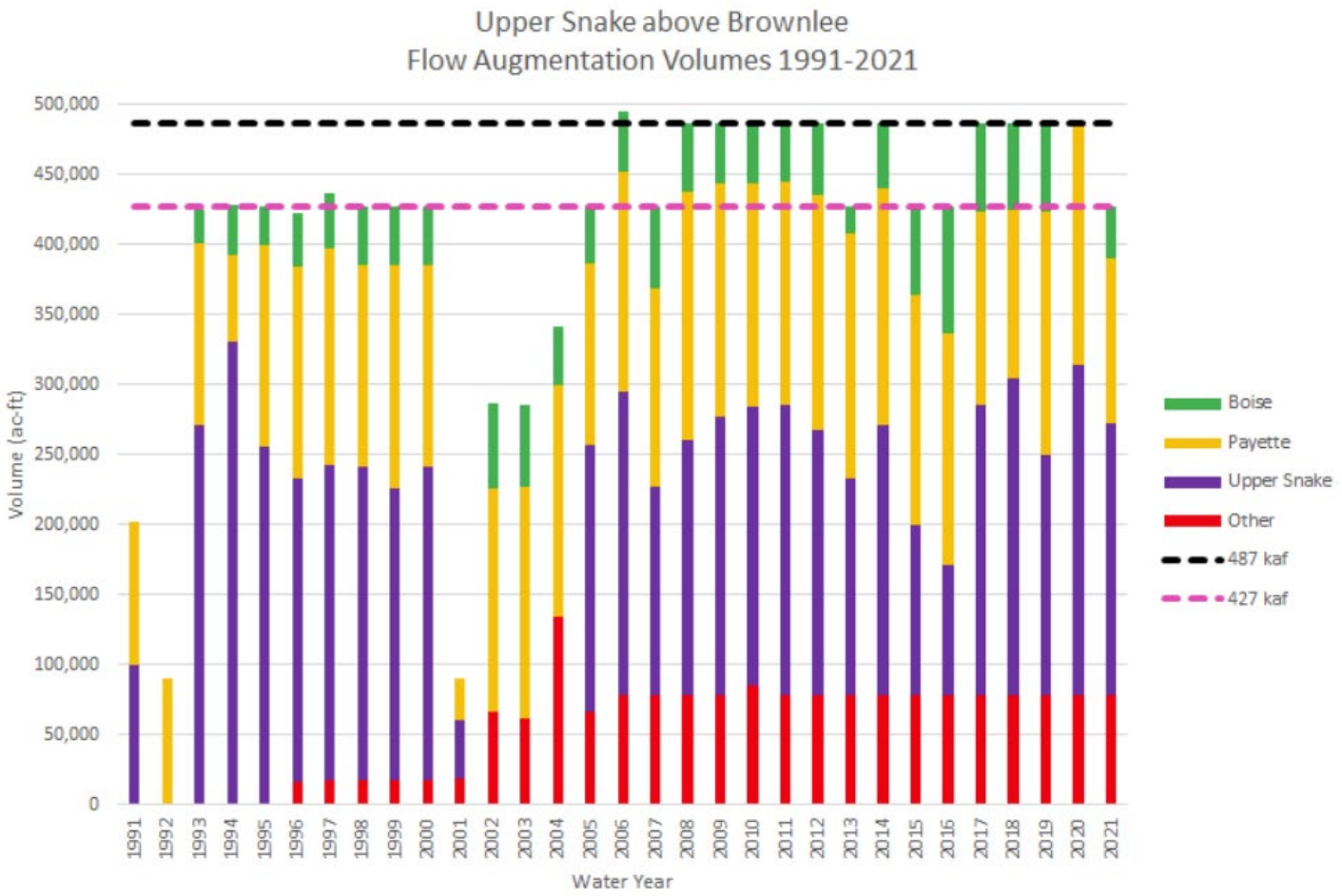
Upper Snake River flow augmentation

- 1992 – Council called for Snake Basin flow augmentation to benefit out-migrating juvenile fall chinook and to reduce summer water temps.
- Water to be provided by a combination of reservoir waters from these three basins.
- 1993-2004: **427,000 acre-feet** was provided (original amount)
- After 2004: **487,000 acre-feet** to be delivered between June and August.
  - 2004 Nez Perce Water Rights Settlement
  - 2005 Upper Snake Biological Opinion



BOR presentation December 2021

Upper Snake River flow augmentation



BOR presentation December 2021

- Flow augmentation in the Upper Snake River above Brownlee Reservoir has consistently met the 427,000 acre-feet target since 1993
- **The 487,000 acre-feet target has been met 65% of the time (11 out of 17 years).**
- In 2008, NMFS recommended the flow be released earlier for spring and summer migrants.

Juvenile Migration Discussion: Spring season

Targets create mechanisms to provide flows for migrating salmon in all water years.

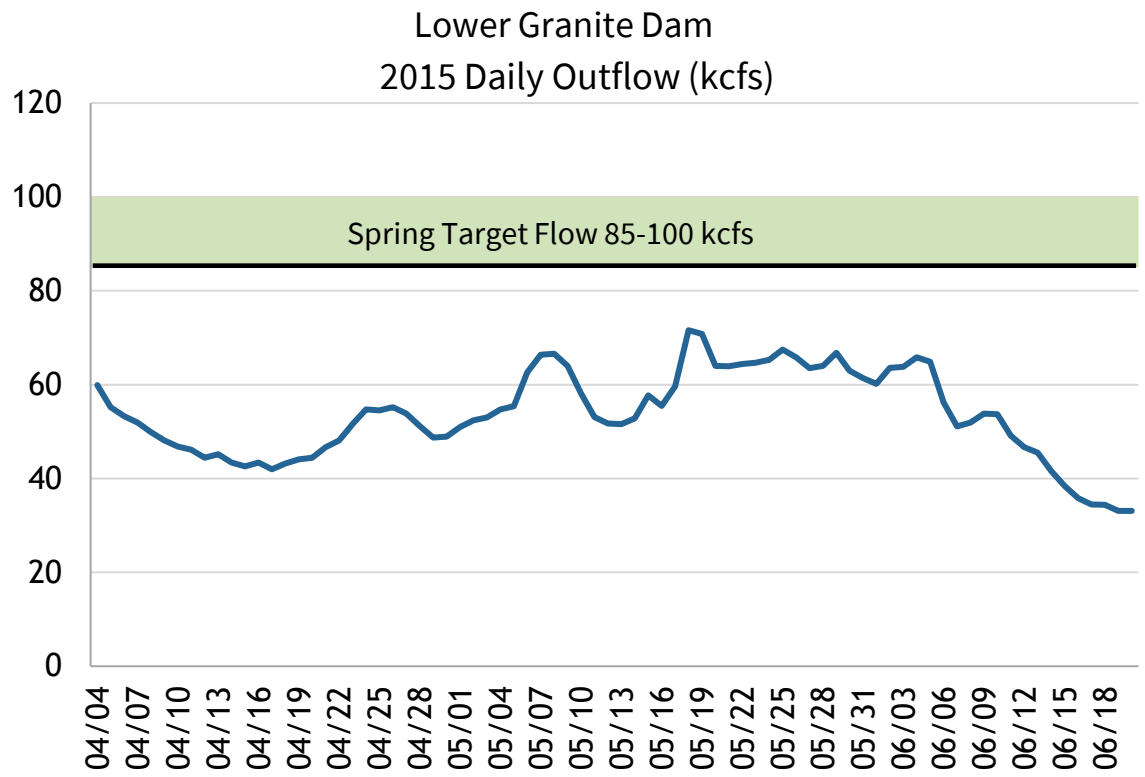
How do we sustain and improve the ability to meet spring flows in the future?

Environmental conditions:

Annual upstream flows and **runoff timing** affect how easy it may be to reach a seasonal target flow.

Management decisions can benefit fish despite a lack of ideal flows.

Is there more to be done to make Upper Snake flow augmentation more effective?



Seasonal flows are just one part of effort to increase survival of juvenile salmon and decrease migration time

Adult Migration

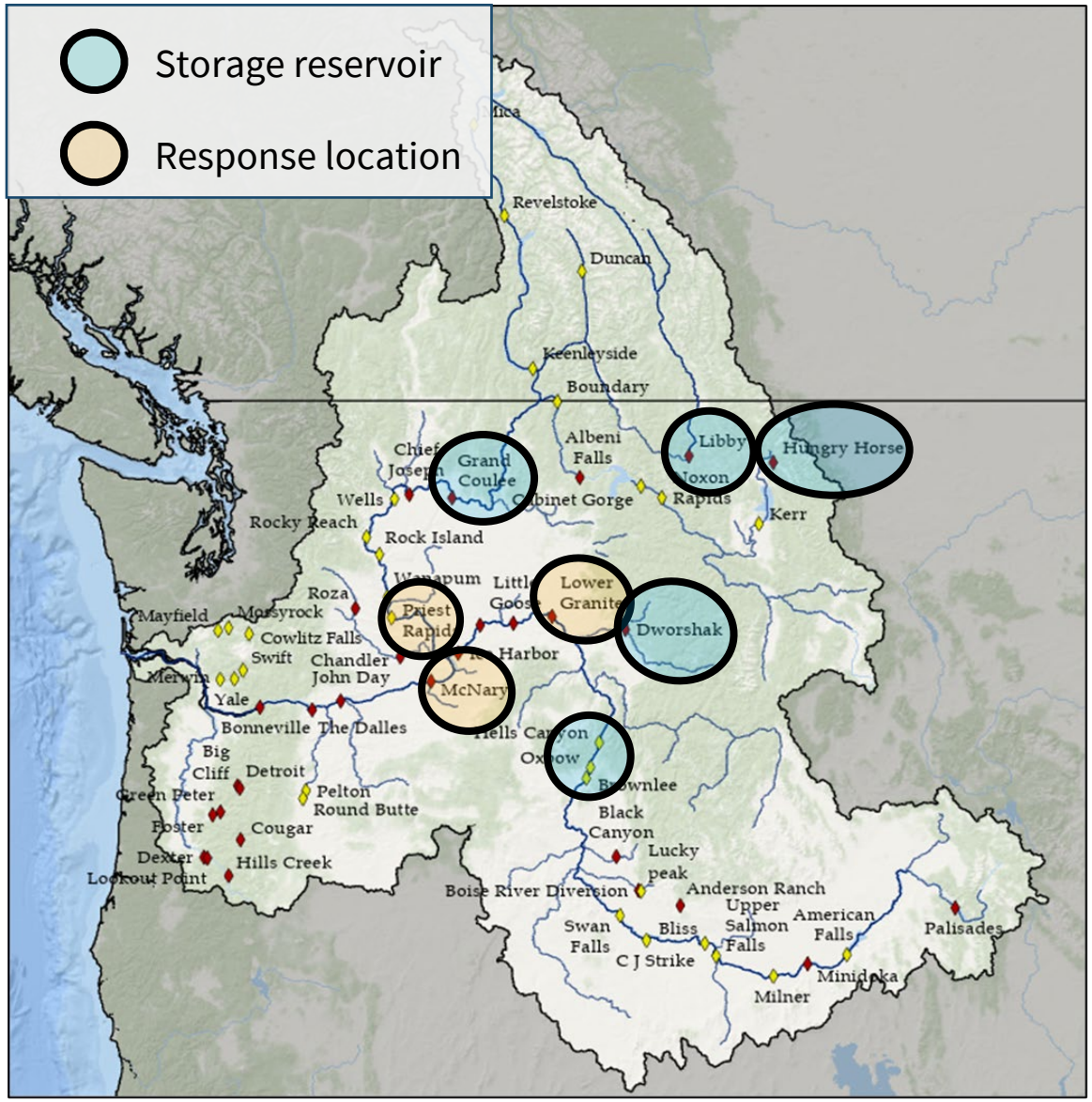
Salmon/Steelhead
- Summer flows
- Temperature management
- Passage structures and operations

Lamprey
- Passage
- General measures

Action summary (salmon and steelhead):
- Improve migration conditions in the mainstem through managing flow and reservoir elevation, maintaining suitable temperatures; installing and operating adult passage structures and trap-and haul

Action summary (Lamprey):
- Improve migration conditions in the mainstem through managing flow, and designing, installing, and operating Lamprey-specific passage structures

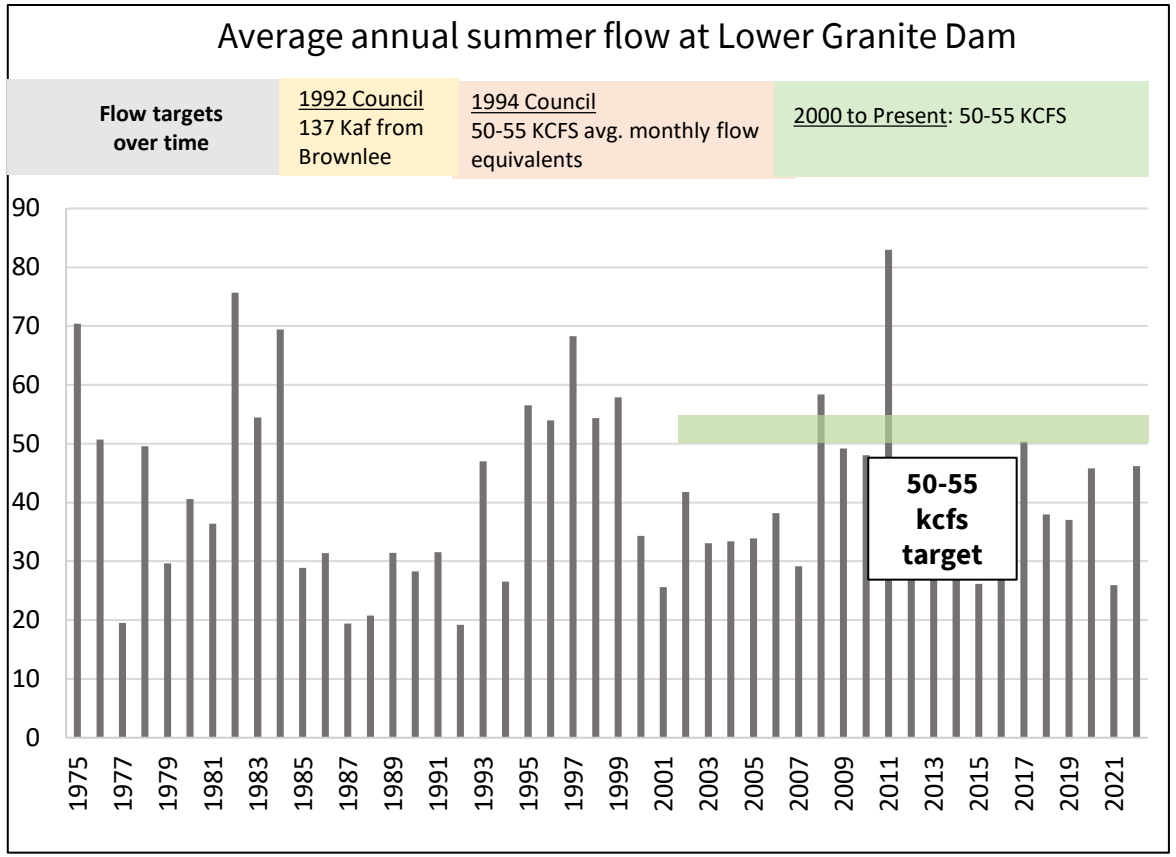
Summer flows and temperature management



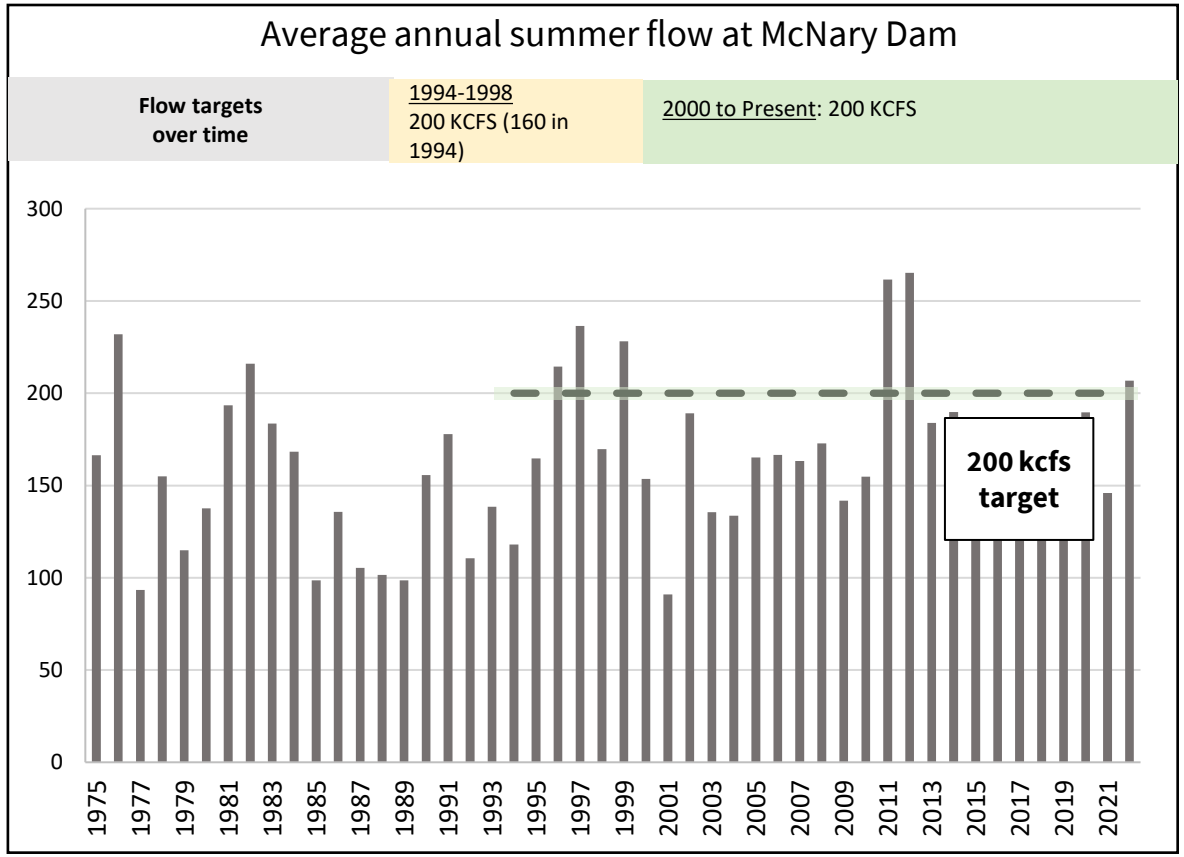
Location of major dams (diamonds; red = federally owned, yellow =publicly or privately owned) in the Columbia River Basin. Map created in ArcGIS Pro (C) 2020 ESRI. All rights reserved.

1994 Council	**Average monthly flow equivalents at Lower Granite.** **Allow Dworshak to draft to 1,520' by the end of July and Grand Coulee to draft to 1,280' by the end of August if needed to meet summer flow and velocity objectives.**
'94-'98 BiOps/ Council - Present	**Seasonal average flow target ranges or targets (also benefit juvenile migrants)** • Lower Granite (50-55 kcfs) • McNary (200 kcfs)
2009 Council	**Subject to in-season management, draft Lake Roosevelt to the target elevations of 1,278 or 1,280 feet by the end of August.** **Release water from Dworshak Dam aligned with BiOps to provide cool summer water temperatures.**

Summer flows and temperature management



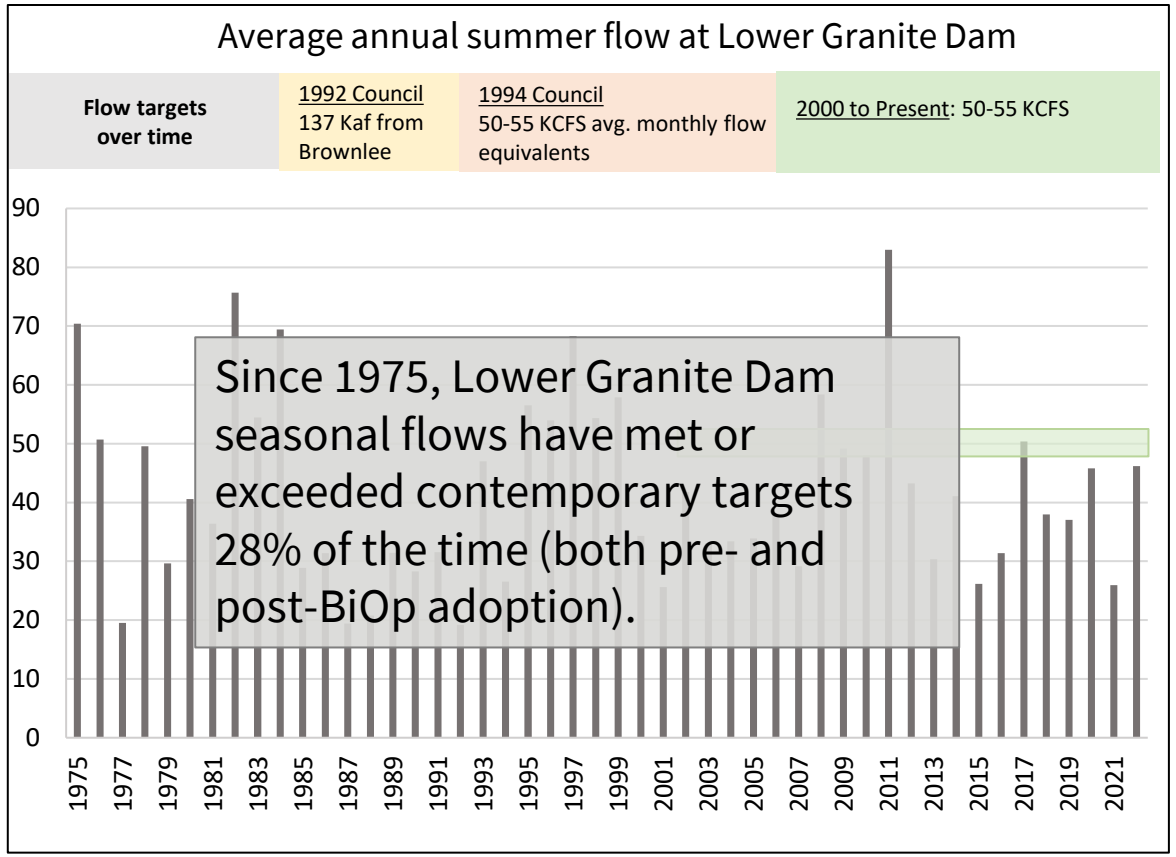
The contemporary average summer flow target range at LGR is 50-55 KCFS



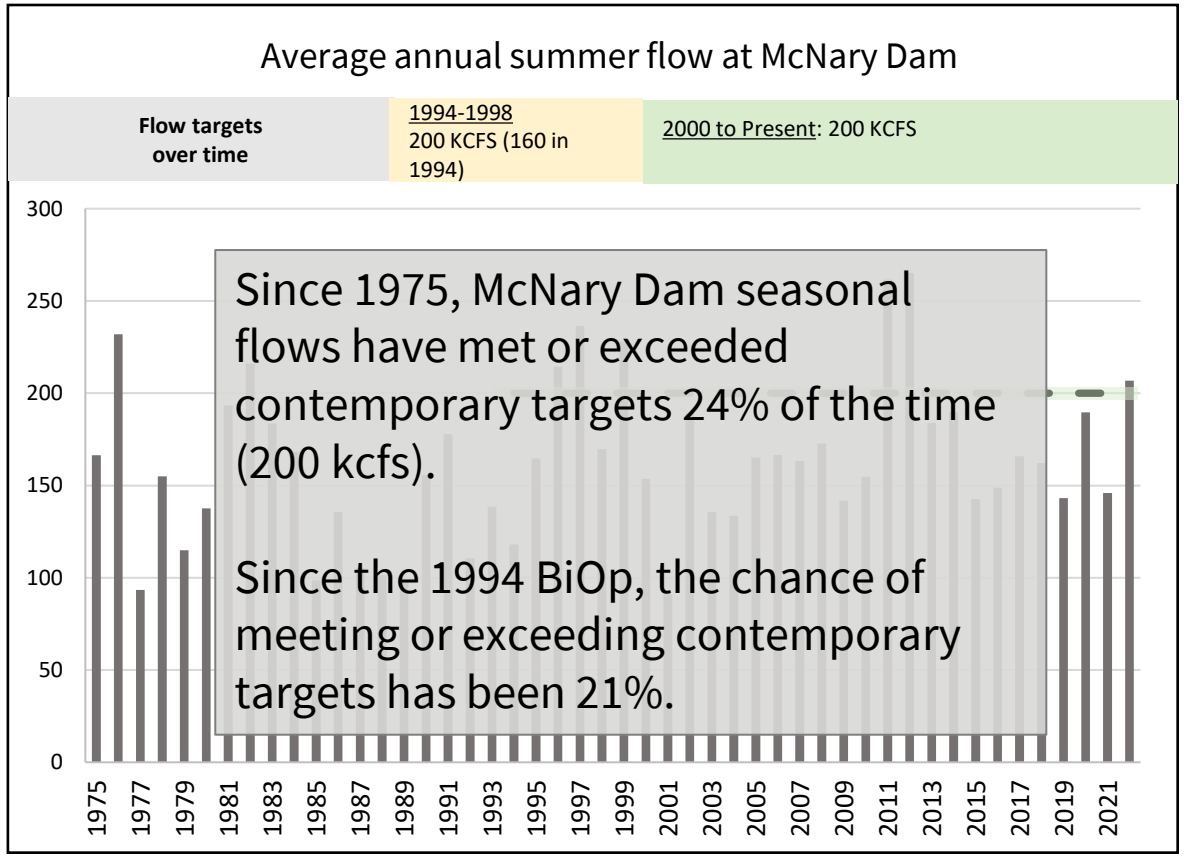
The contemporary average summer flow target at MCN is 200 KCFS

Note: Contemporary flow data and targets available on Program Tracker, SPI E3-1

Summer flows and temperature management

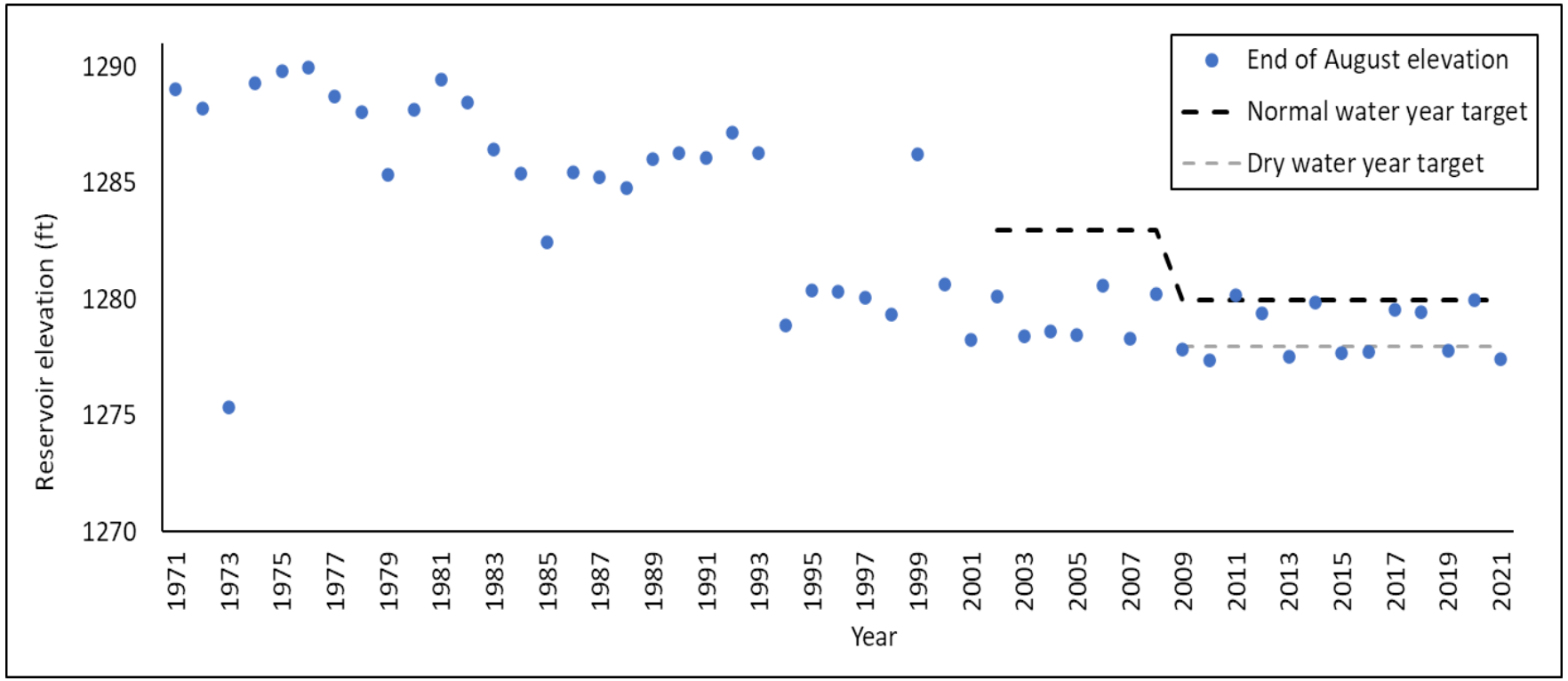


The contemporary average summer flow target range at Lower Granite Dam is 50-55 KCFS



The contemporary average summer flow target at McNary Dam is 200 KCFS

Summer flows and temperature management

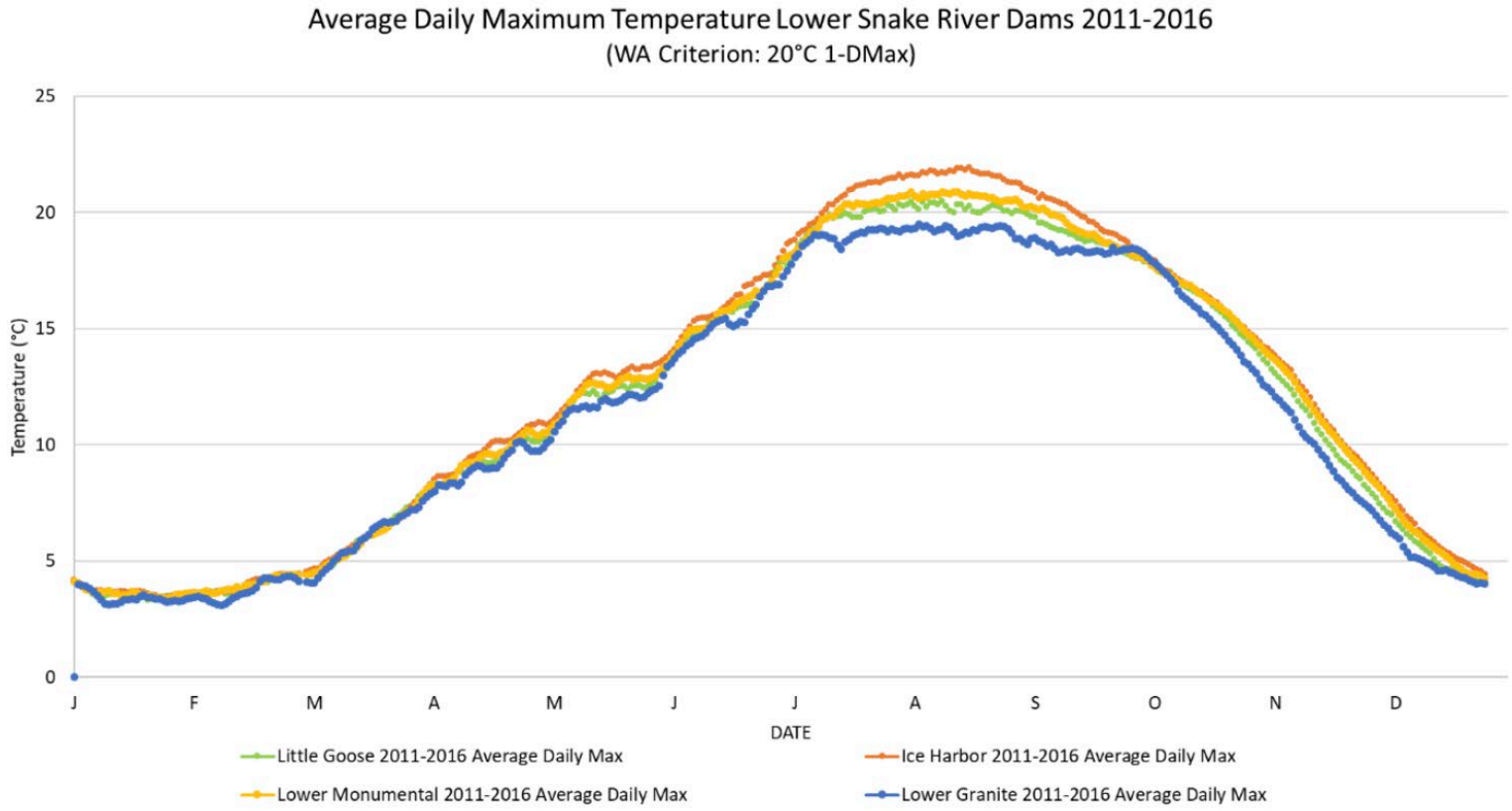


Reservoir elevation (ft; blue dots) at the end of August relative to draft limit (black dash), at Lake Roosevelt, Grand Coulee Dam, 1971 – 2021.

In order to meet summer basin flow and velocity objectives, water is drafted from upstream reservoirs including Grand Coulee (Lake Roosevelt) and Dworshak Dams.

Summer flows and temperature management

- Target water release temperatures vary: 48°F (8.9°C) to 51°F (10.6°C) during July and August.
- Target water temps balance fish production at the downstream Dworshak National Fish Hatchery and anadromous needs in the lower Snake River.
- Cool summer releases from Dworshak typically contribute 25-45% of the Snake River flow.



Snake River warming as it flows downstream from Lower Granite Dam (blue) to Ice Harbor Dam (orange). Source: epa.gov

Note: Contemporary temperature data and targets available on Program Tracker, SPI E2-2, E2-4

Summer flows and temperature management discussion

- Summer flow targets are met less frequently than spring flow targets due to competing priorities.

Do we need any changes to flow requirements? Seasonal priorities?

- High flows in July and August help downstream migrants, while high flows and low temperature are best for adult fall Chinook in September (EPA, 2003).

Will current drawdowns provide sufficient temperature relief after incorporating variable operations and a changing climate?

Are current precipitation forecasting methods sufficient to account for shifts from less snow to more rain or more frequent extreme events?

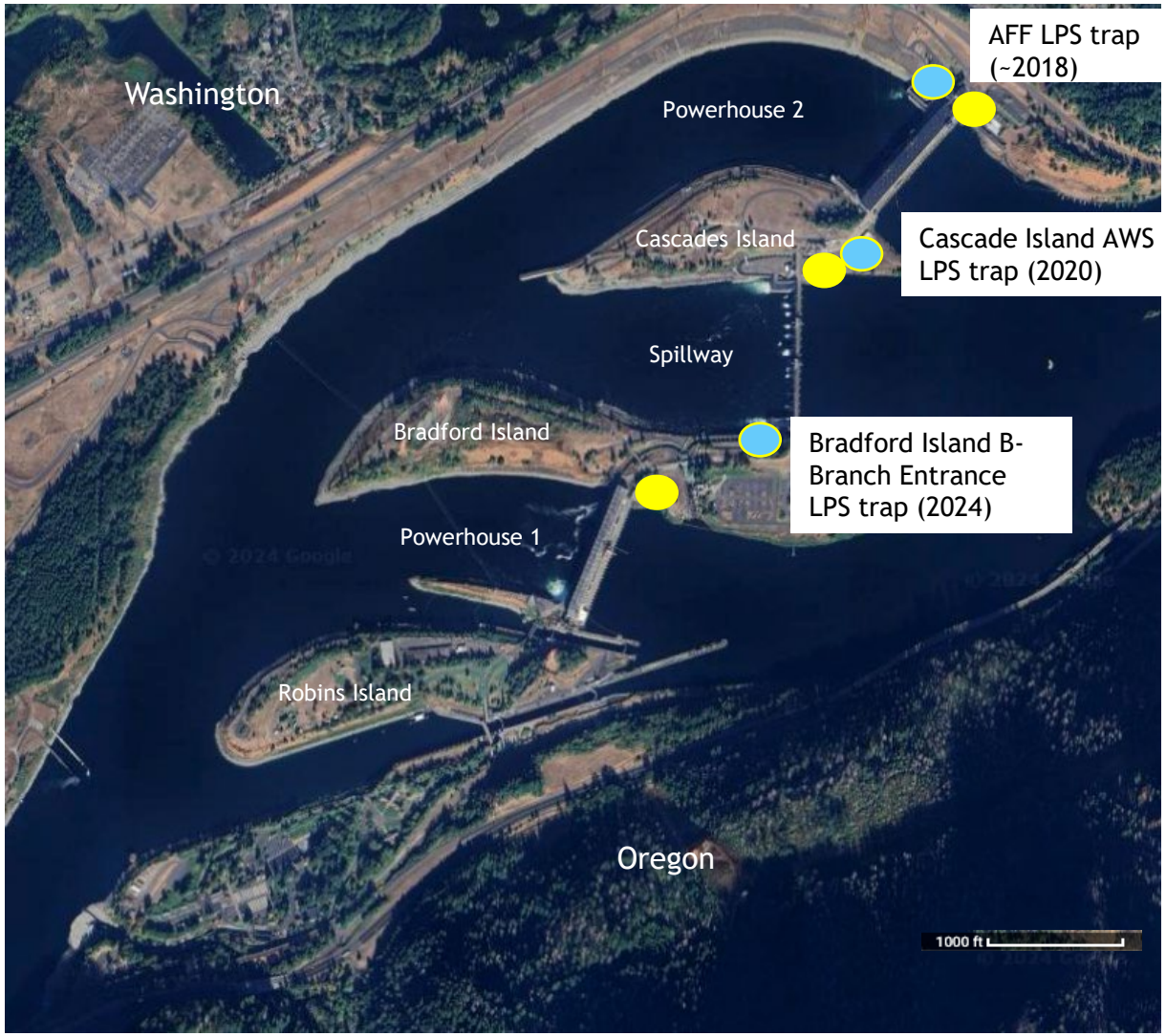
Lamprey passage

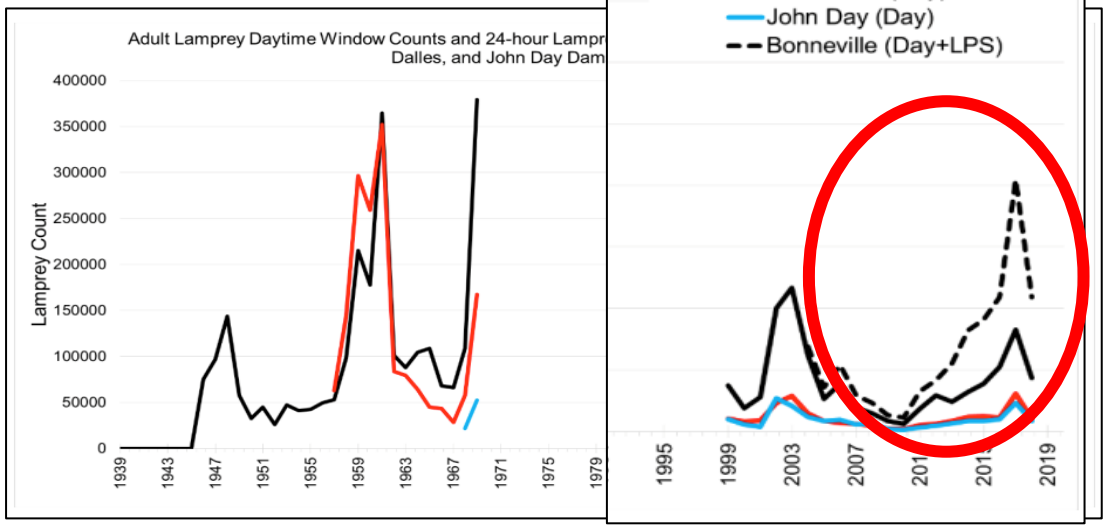
Strategy	Description
Lamprey	Implement actions that result in increased abundance and survival for lamprey, including habitat actions, dam operations and passage, monitoring populations, and research to improve understanding of how the development and operation of the Federal Columbia River Power System affect migration success, survival and growth of lamprey.
Strategy Performance Indicator	
L1-4	Abundance of juvenile and larval outmigration tracked at John Day Dam and Bonneville Dam.
L3-1	Adult passage efficiency for each Columbia and Snake mainstem dam (in development).
L4-2	Annual weighted average injury rates for Pacific Lamprey macrophthalmia at Bonneville, McNary and John Day dams.

1994 Council	Call for research needs for lamprey passage at mainstem Columbia River dams.
2008 MOA Columbia Basin Fish Accords	Guarantee at least 10 years of research and passage improvements (USACOE, 2018).

- Targeted measures to track both adult lamprey returning and juvenile lamprey heading downstream are integral to improving survival through the hydrosystem.

Lamprey Passage at Bonneville Dam





- Lamprey-specific passage is still a relatively new concept but has already shown improved numbers.
- Lamprey have different needs than salmonids.
  - Infrastructure
  - Run timing with spring flows
- Counting is still very complicated --> Potential for new SPI?

Lamprey Passage at Bonneville Dam

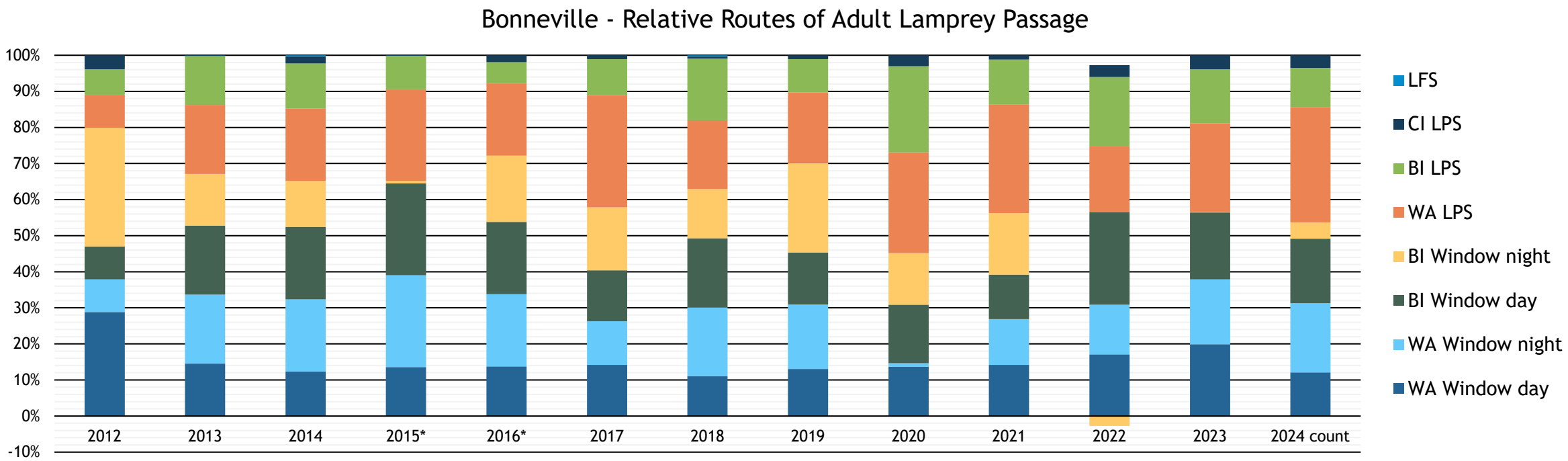


Figure 2. Proportional routes of passage for adult Pacific lamprey at Bonneville Dam. These can differ from PIT tagged or radio tagged fish. Data from table 2 above.
I've omitted negative WA night counts here for convenience in all years to allow comparison of trends. Just realize that LPS & LFS counts are 24 hours / day, Window Day for 16 hours/day.
The LFS was not operated in 2016 after an access hatch was discovered missing at low tailwater ~9 feet
The LFS was operated in 2017 collecting 51 lamprey. However, we were not able to actuate the lower entrance pickets suggesting it is plugged with sediment or other debris. An ROV inspection in 2018 did not see any debris. Lower picket gears are rusting.
* In 2015, 2016, and 2022 massive negative night counts, likely due to recycling at BI & WA shore makes those data difficult to interpret.

Hanford Reach Fall Chinook

- Seasonal flow
- Stable flow

Chum Salmon below Bonneville

- Seasonal flow

Mainstem Spawning and Rearing (salmon)

Program action summary:

- Improve spawning, incubation, emergence, and rearing conditions for mainstem spawners through providing suitable and stable flows

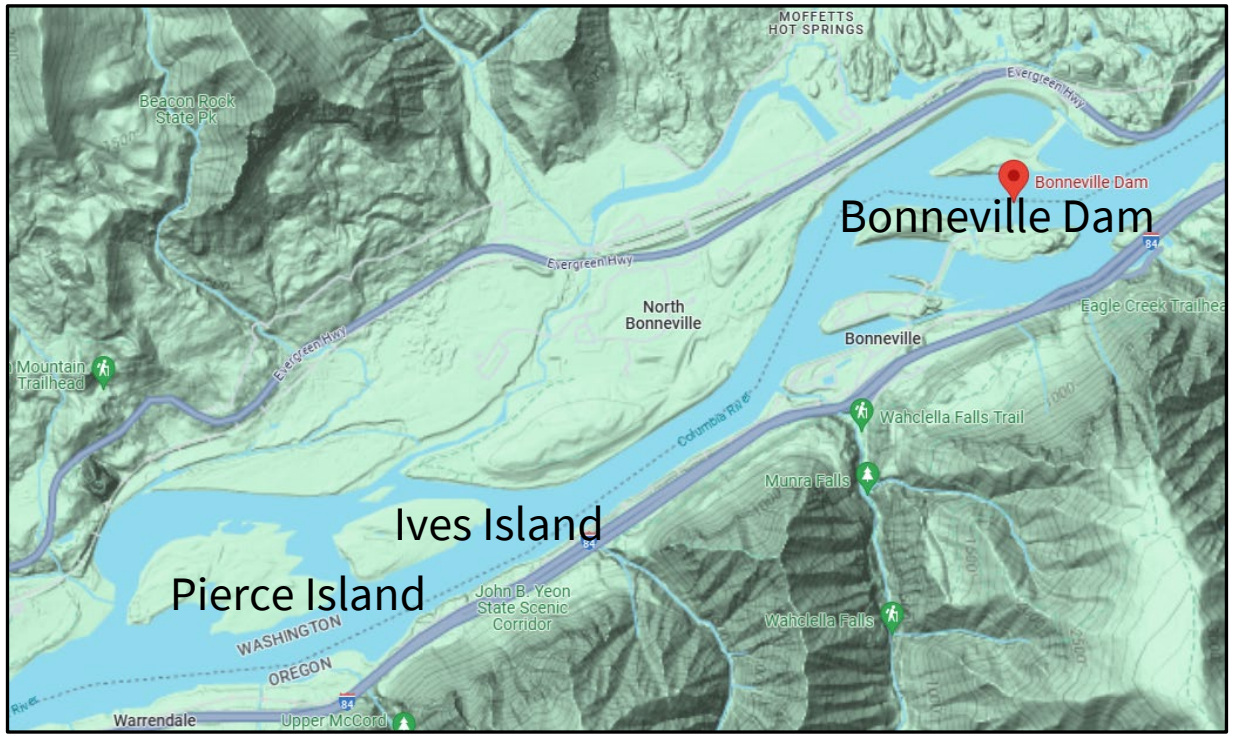
Chum salmon below Bonneville

Spawning:

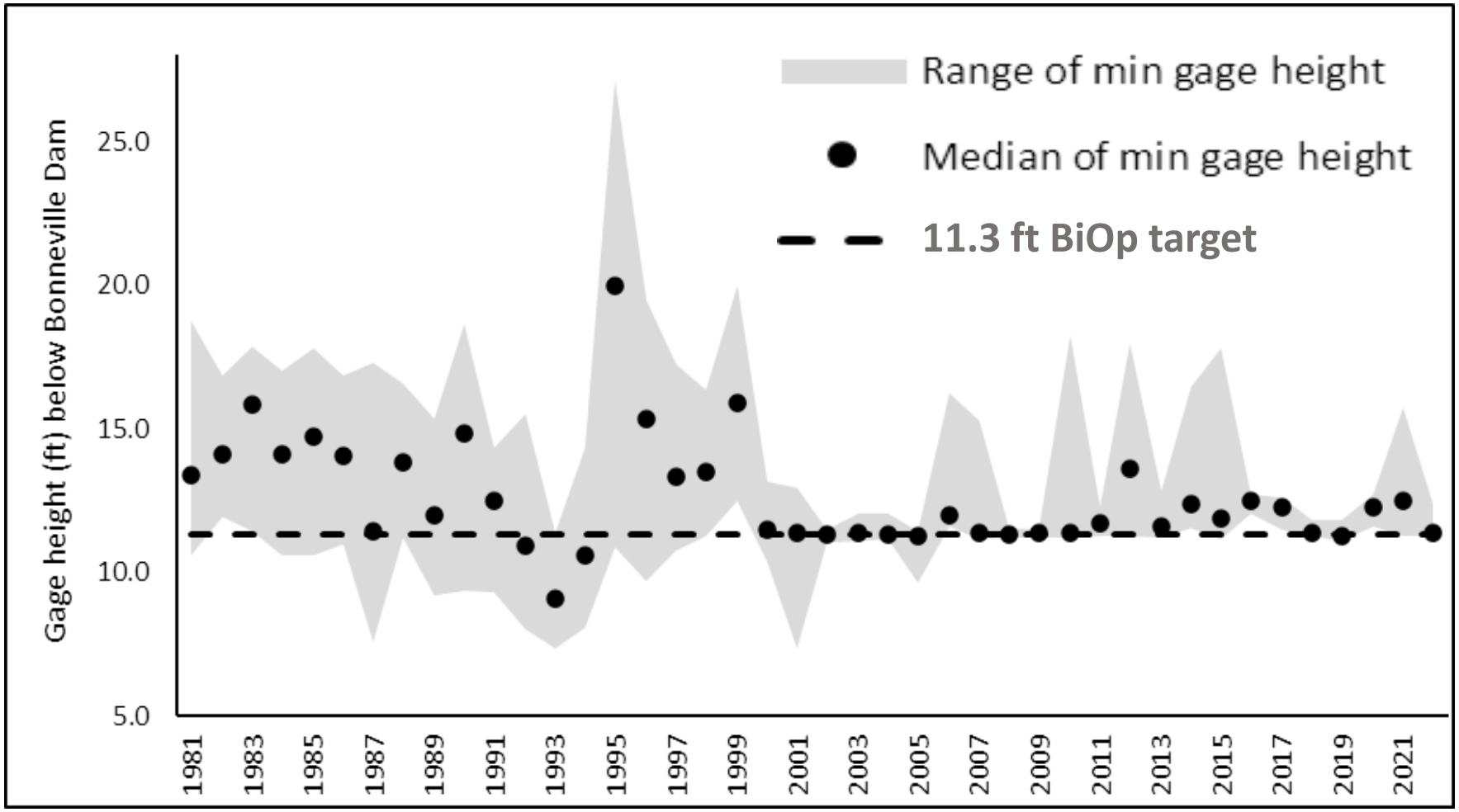
- Tailwater ~ 11.5 feet; Nov - late Dec
- Maintain at 11.3 - 13.0 feet during spawning on Ives/Pierce Islands

Incubation and emergence:

- Tailwater elevation set in late Dec based on observed redd depth and forecasted water supply through emergence



Spawning
(truncated to Nov 10 – Dec 20)



- Since listing, tailwater elevations more consistently above 11.3 ft
- Provides access to spawning tributaries

Incubation and emergence (Jan – Mar)

- Less variation among years in minimum spring elevations
- In low water years, no spring season set

Discussion

Tailwater elevations are lower priority than spring flows and summer refill

- Only provided when sufficient water to meet high priority operations
- Contingent on sufficient water to maintain elevation through emergence
- In drought years, flow may not be provided

How might frequency of chum operations change in future, considering climate change, water availability, or new operations?

Tailwater elevations initiated on Nov 1 at the earliest, or when chum observed on spawning grounds

- Chum regularly counted at Bonneville Dam beginning in October

Does waiting to increase flows until chum observed on spawning grounds delay access to tributaries for early spawners?

Resident fish, by location

Columbia/ Snake River (Sturgeon)
- Flow and temperature
- Passage

Libby and Hungry Horse: downstream
- Minimum flow
- Sturgeon pulse
- Seasonal flows
- Ramp rates
- TDG
- Temperature

Libby and Hungry Horse: reservoir
- Reservoir drawdown
- Reservoir refill
- Stable reservoir elevation
- Reservoir end of summer draft

Grand Coulee
- Refill
- Stable reservoir elevations
- Fall draft limits for kokanee
- Water retention time

Albeni Falls/Pend Oreille
- Reservoir refill
- Reservoir drawdown
- Passage

Action summary:

- Improve downstream and reservoir ecosystem conditions through management of flow, temperature, TDG, and passage

Columbia/ Snake River Sturgeon

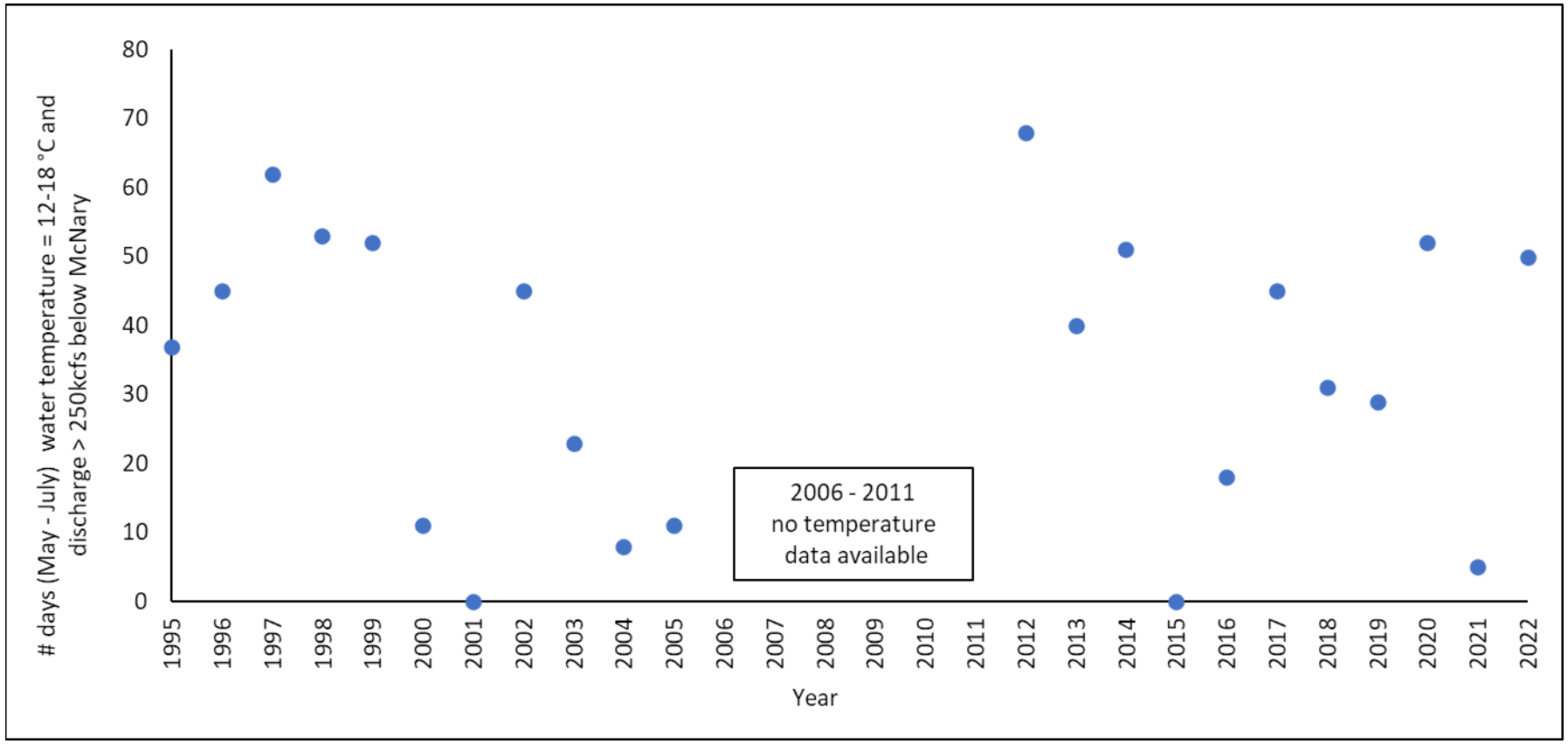
- Continue to improve adult fish passage facilities at mainstem dams

- Seek opportunities to provide beneficial flows, including:
  - increase spring and summer flows
  - reduce flow fluctuations during spawning
  - spill where feasible

- Identify whether feasible/how to implement flows without negatively affecting salmon, steelhead and lamprey

Spawning and productivity below McNary positively associated with number of days temperature = 12 – 18°C and flow > 250 KCFS, May – July

- Parsley et al. 1993
- CBWSPF 2013



- Hourly flow data at McNary Dam
- Hourly temperature data below McNary
- Contemporary temperature and flow data and targets available on Program Tracker, SPI E3-4

Number of days with a combination of average temperature within the range of 12 – 18°C and average flow > 250 KCFS, May – July, below McNary, 1995 – 2022.

- No passage measures have been implemented
- No specific flows for Sturgeon are implemented
  - Suitable flows occur during higher water years or as corollary to operations targeting other species- particularly salmon and steelhead

Discussion

Passage limited and primarily in downstream direction

- Upstream populations lose individuals and genetic diversity to downstream populations
- Fragmentation prevents migration to higher quality habitat

Ongoing need to implement existing passage measures for sturgeon

Variable temperature and flow conditions

- No determination of whether feasible to implement flows > 250 kcfs
- No description of how to implement flows
- No benchmarks for # days needed to achieve biological response

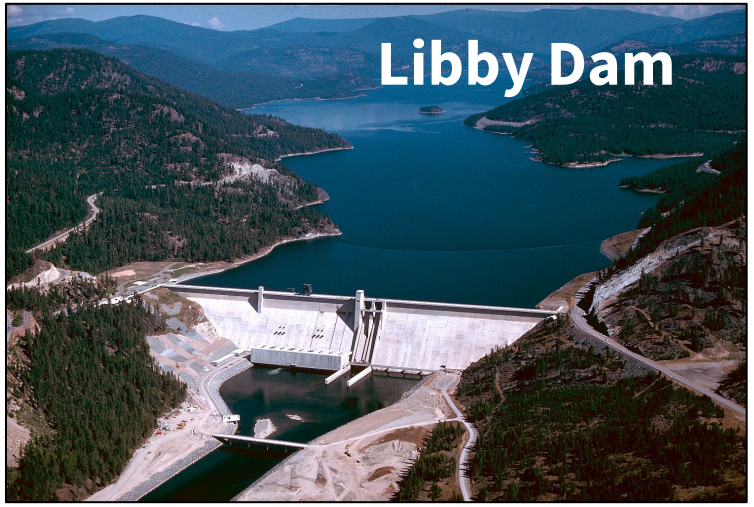
Ongoing need to implement existing flow measures for sturgeon

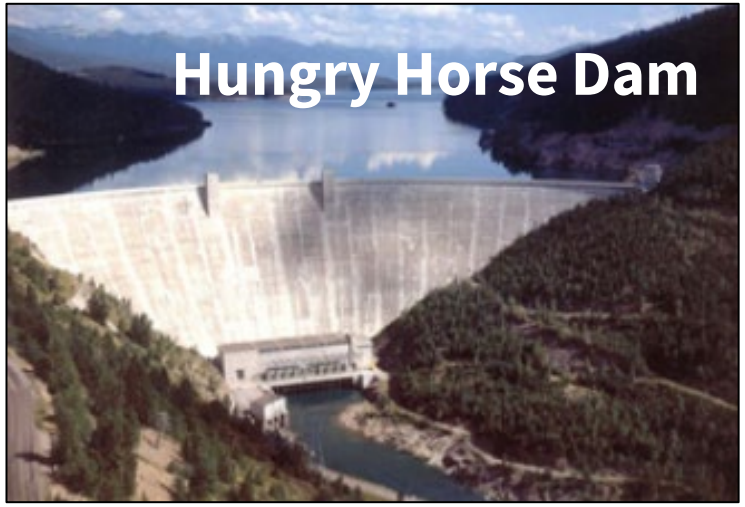
Temperatures May – July shifting toward more days > 18 °C and fewer days < 12 ° C

If trend continues, fewer days will be within combined temperature/ flow range

Libby and Hungry Horse: Downstream operations

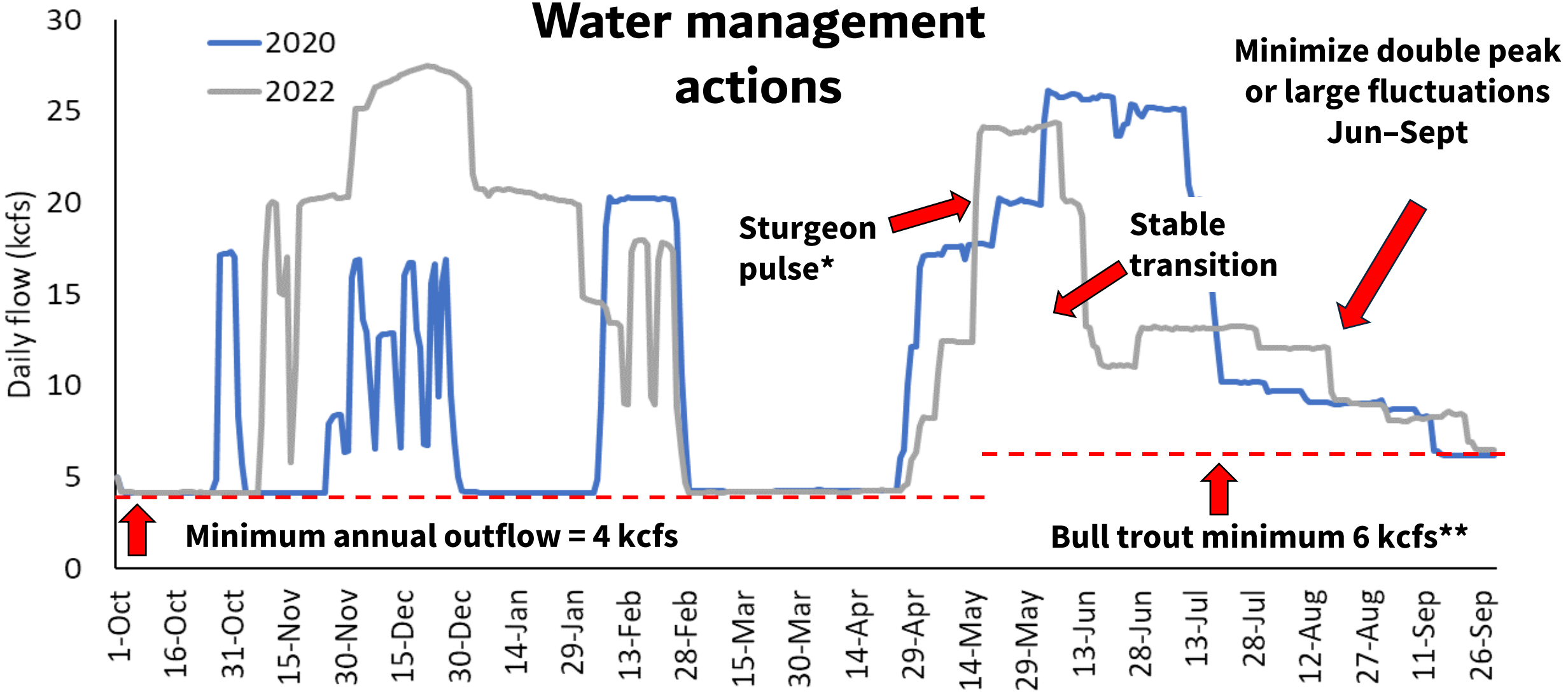
Not covered:
- Ramp rates
- Temperature
- TDG





Sturgeon pulse:	• Supplemental flow releases mid May –Jun • Volume based on water forecast	• NA
Minimum and seasonal flows:	• Annual min flow 3 – 4 KCFS • May – Sep: 6 KCFS • Jul- Aug: 6 - 9 KCFS	• HGH min outflow- 400 – 900 CFS • Columbia falls min flow 3,200 - 3,500 CFS

Water management actions



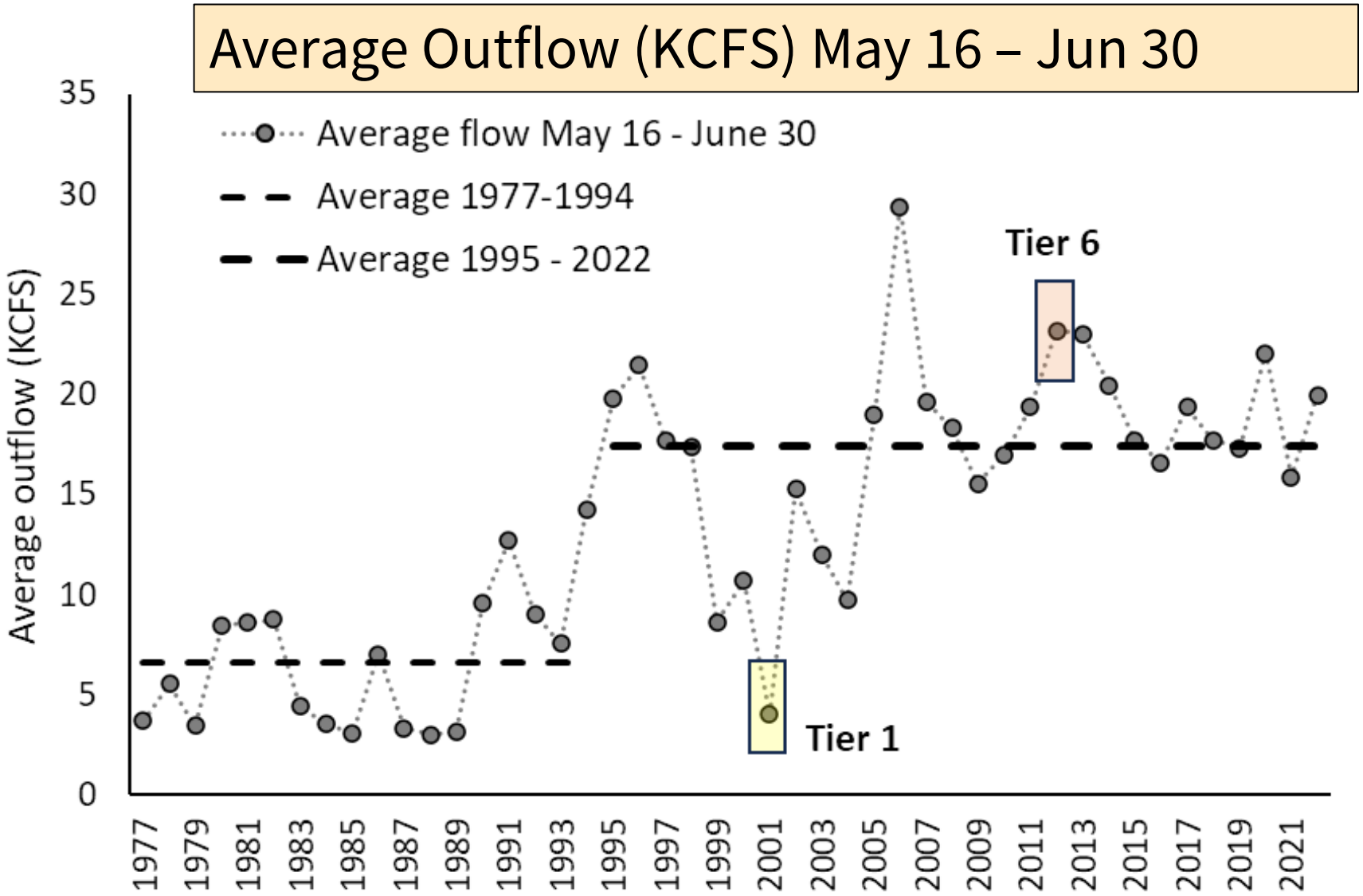
* Sturgeon flows tiered to runoff forecast (6 flow tiers)

** Bull trout minimum flow:

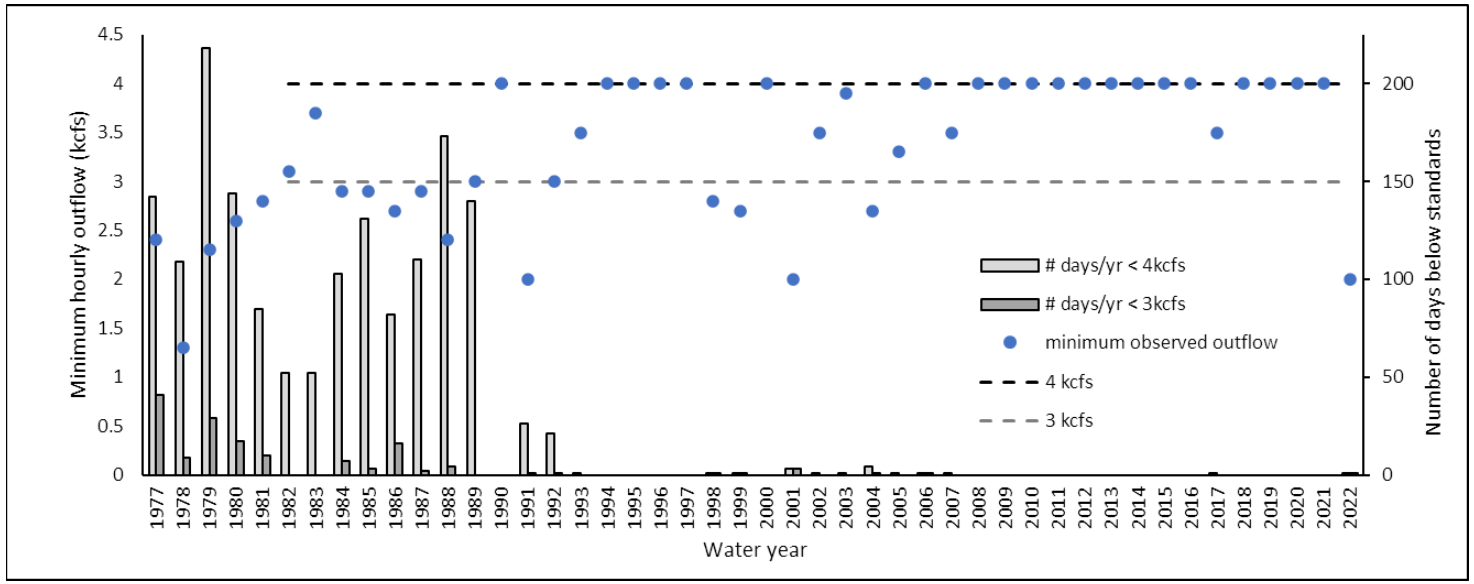
- May 15 – Sept 30 = 6 kcfs
- July 1 – Aug 31 = minimum flow 6 – 9 kcfs, depending on runoff forecast

Sturgeon pulse: Libby Dam

Kootenai River White Sturgeon flows began in 1995 following ESA listing



Minimum annual and seasonal flows

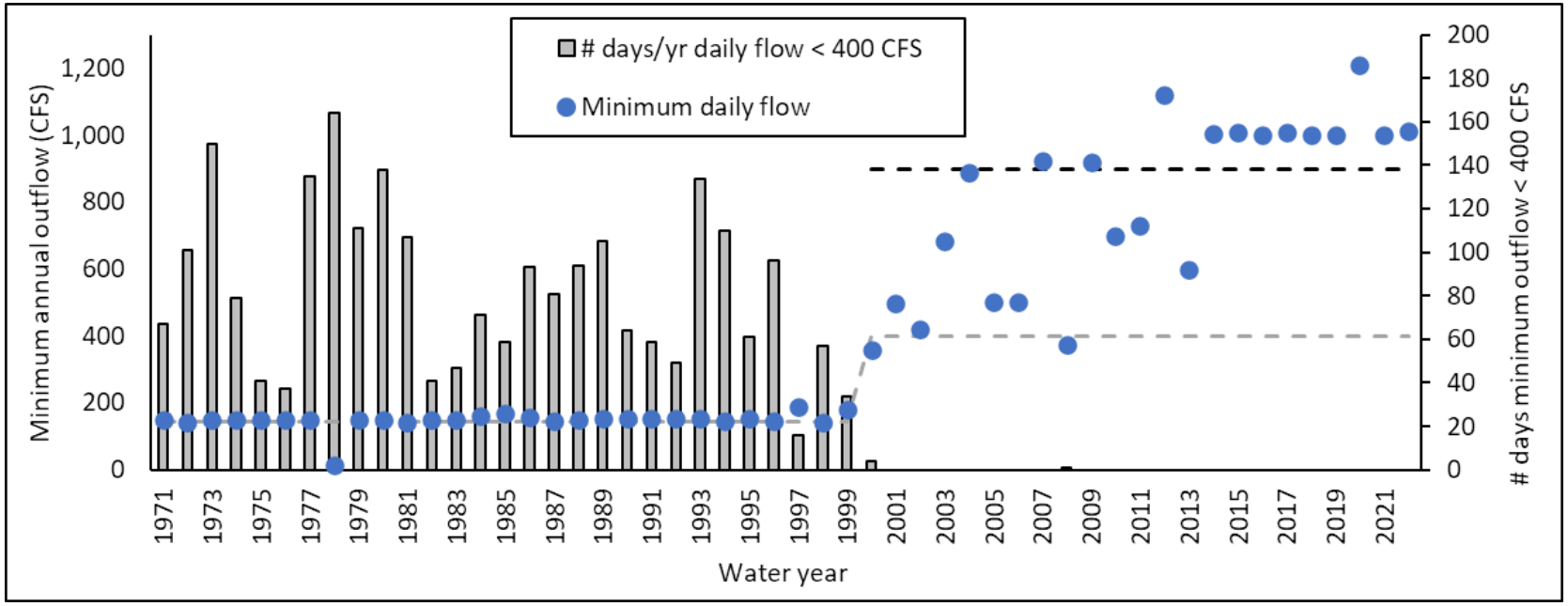


Libby minimum flows

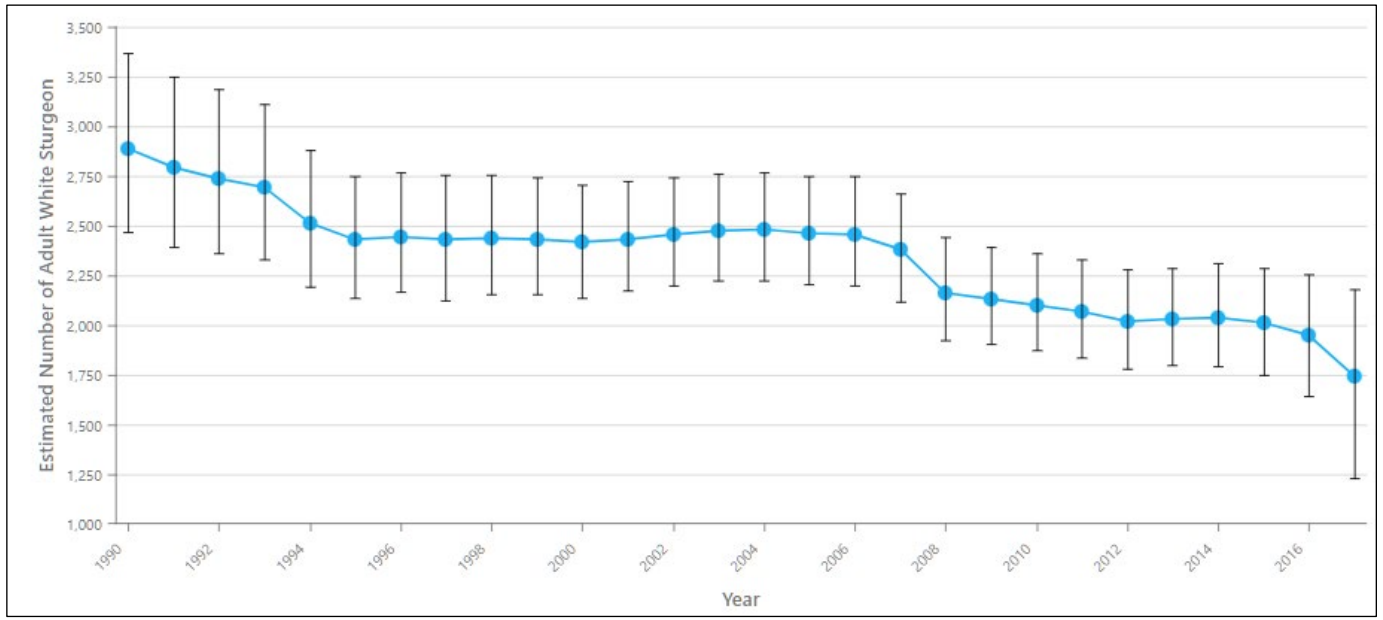
- Almost always at normal water year target
- May – Sept flows for bull trout more frequently met
- Jul- Aug flows almost always met

Hungry Horse min outflow

- Increased after bull trout listed
- Consistently above upper target



Estimated number of adult white sturgeon in the Kootenai River, 1990–2017



Strategy Performance Indicator WS1-8

- Despite implementation of flows, continued sturgeon declines

What options exist to address other local factors (habitat, food) affecting biological response to suitable flows

Discussion

Minimum and seasonal flows:

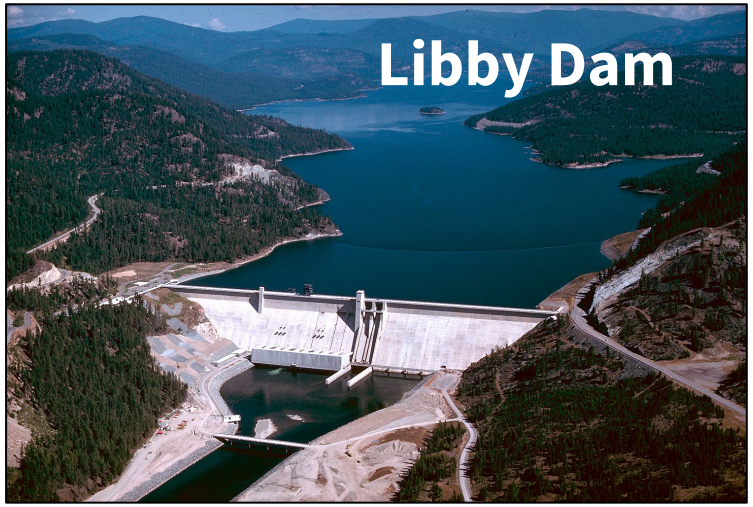
- Substantial increase in flows for resident fish since Bull Trout BiOp in 2000
- Flow operations are high priority and are consistently implemented

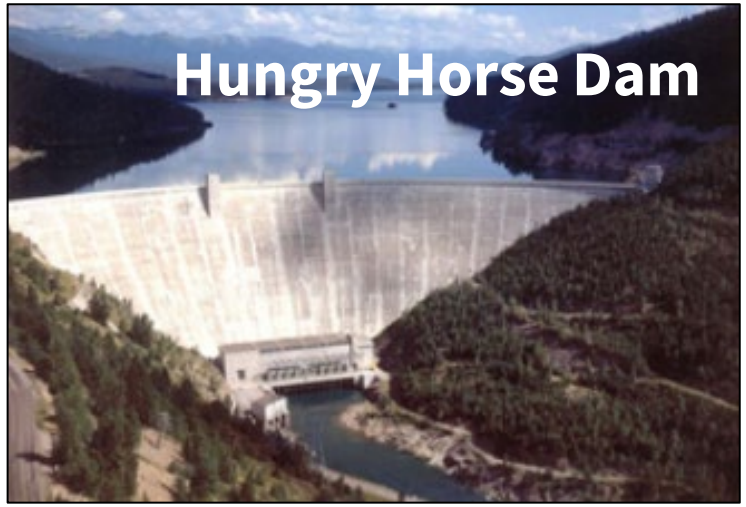
Managers have identified improved habitat connectivity in the Kootenai for bull trout when summer flows approach 9 KCFS. Is it feasible to implement this higher flow level more frequently?

Libby and Hungry Horse: Reservoir operations

Not covered:

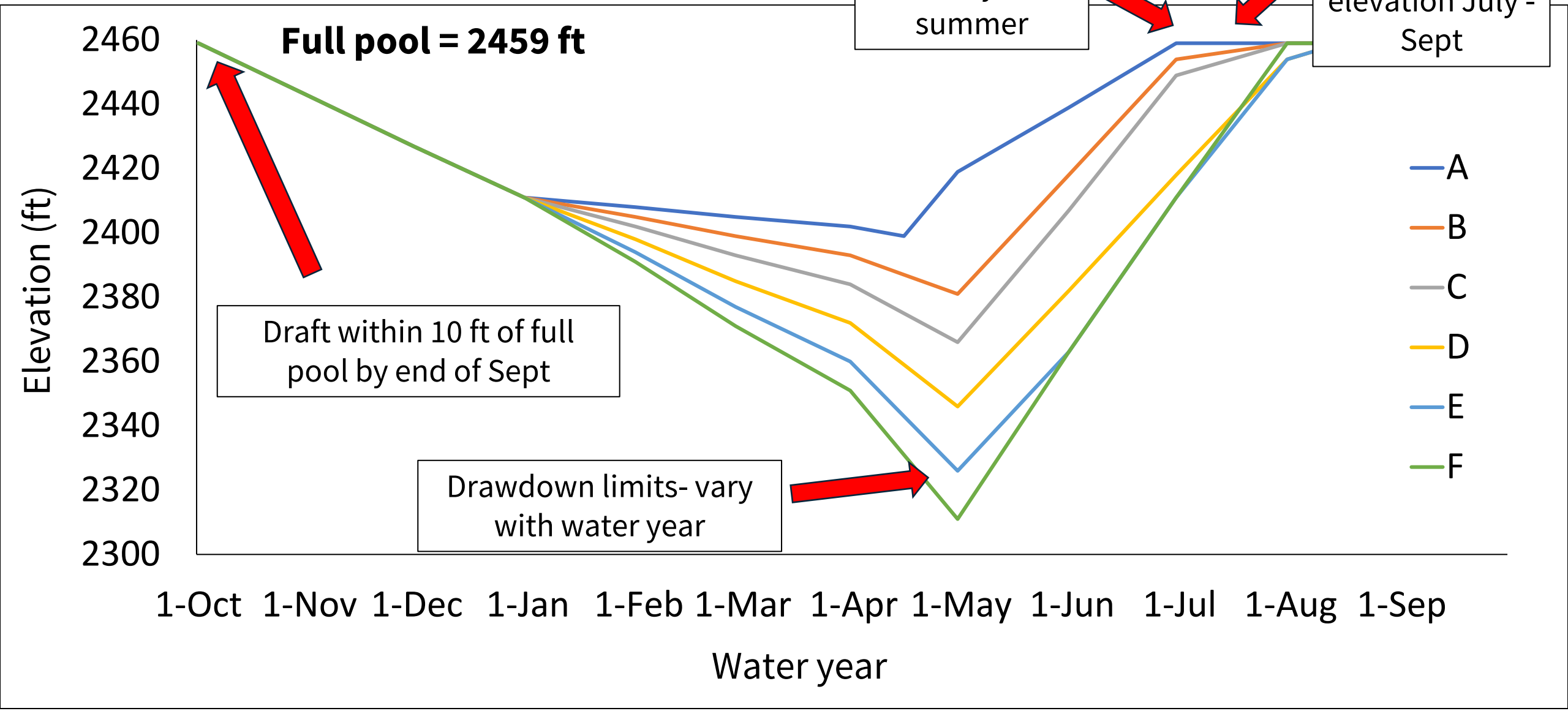
- Stable reservoir elevation





Drawdown	• Original = 90-110 ft from full pool • Current = determined from IRC	• Original = 85 ft from full pool • Current = determined from IRC
Refill	• Original = full pool by end of July • Current= 5 ft from full pool	• Original= full pool by end of June • Current = 5 ft from full pool
End of summer draft	1995 BiOp = < 20 ft by end of Aug 2003 = < 10 ft by end of Sept Current = variable draft (5 – 20 ft)	1995 BiOp= same 2003 = same Current = variable draft (10 – 20 ft)

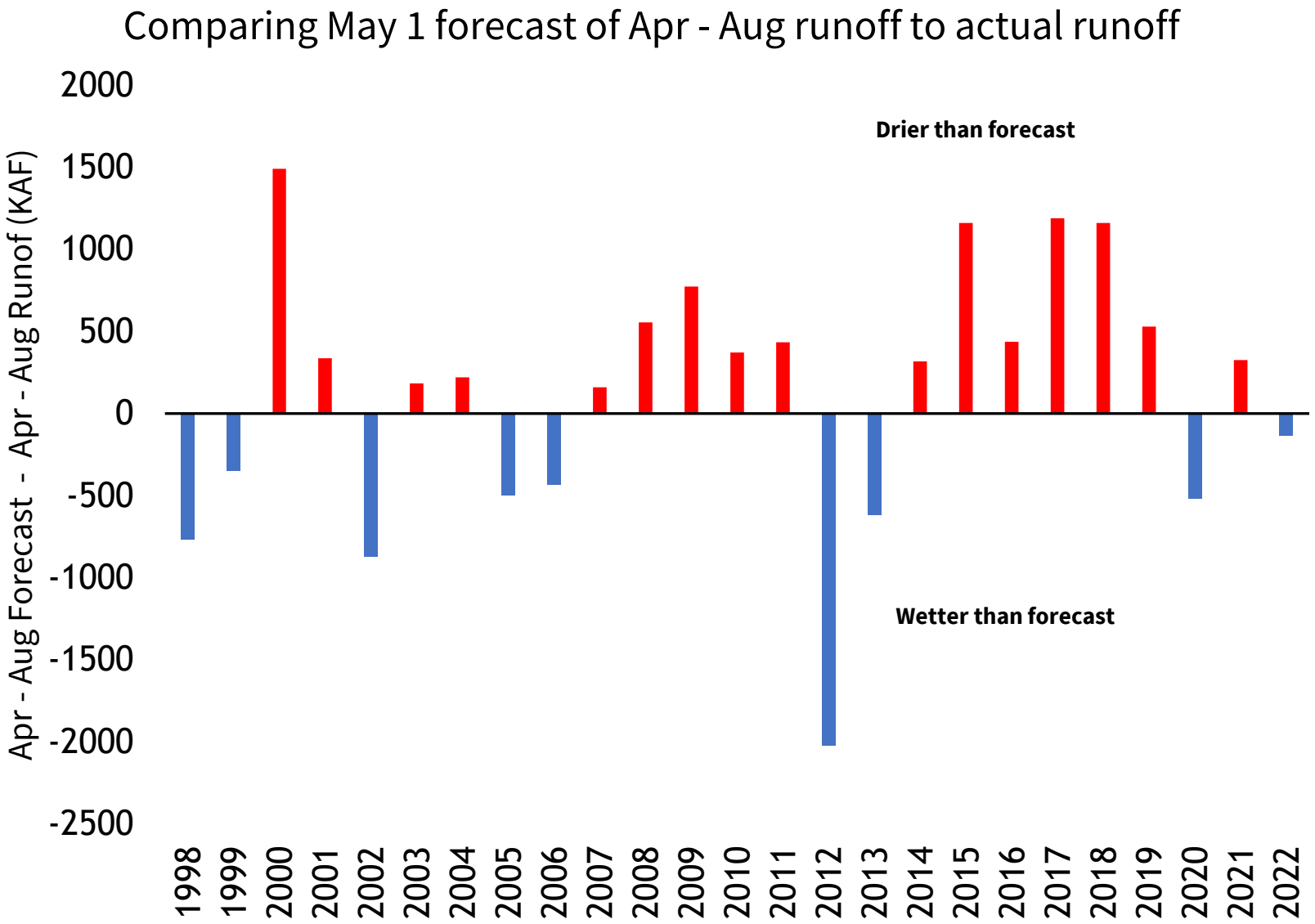
Libby Dam Integrated Rule Curves



Forecasts shape storage reservoir management

- If actual runoff is lower than forecast, drawdown may be too deep to achieve refill

- If actual runoff exceeds forecast, there may be insufficient storage space for flood risk management and excess flow may be spilled (potential TDG issues)



Implementation of operations at Libby and Hungry Horse

- **Integrated rule curves-** adopted in Program and implemented
  - Council played role in helping operations gain regional support and implementation

- **Drawdown**- Both reservoirs no longer drawn down as deeply; more water kept in reservoirs

- **Summer refill** targets Libby typically not met, Hungry Horse typically met
  - New refill target (5 feet below full pool)
    - Decreases potential for involuntary spill and elevated total dissolved gas
    - Creates more favorable temperature conditions in reservoir
  - Achieving Sturgeon and downstream flow targets affects ability to refill reservoir
  - Stable conditions more important than temporarily reaching refill target

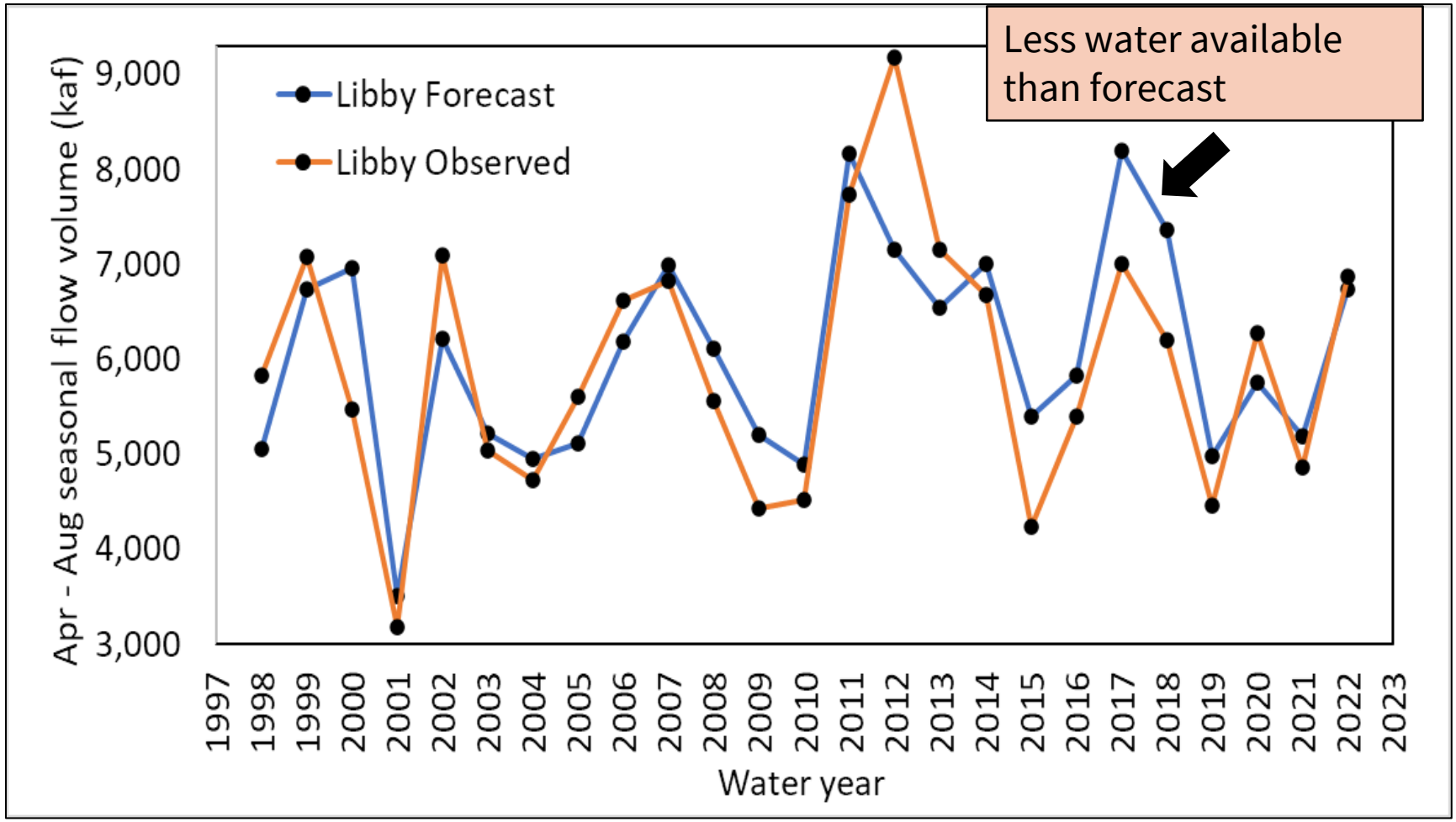
Implementation of operations at Libby and Hungry Horse

- **End of September draft**
  - Libby draft is frequently above dry year limit, especially post 2010, but most draft falls below normal year limit
  - Hungry Horse draft is typically above normal year limit
  - When refill not achieved, less water available to meet September draft limit
  - Until 2020, normal vs dry year draft was driven by forecast at The Dalles
    - not always representative of local conditions
  - Beginning 2020, local forecasts used to determine dry-year operations
  - Variable draft limits based on water forecast

Discussion

Climate/ forecasting challenges

- More precipitation falling as rain; difficult to forecast well
- Runoff at low elevations occurring earlier
- Summer precipitation below average- forecast model assumes average- less precipitation affects fish operations



Improvements

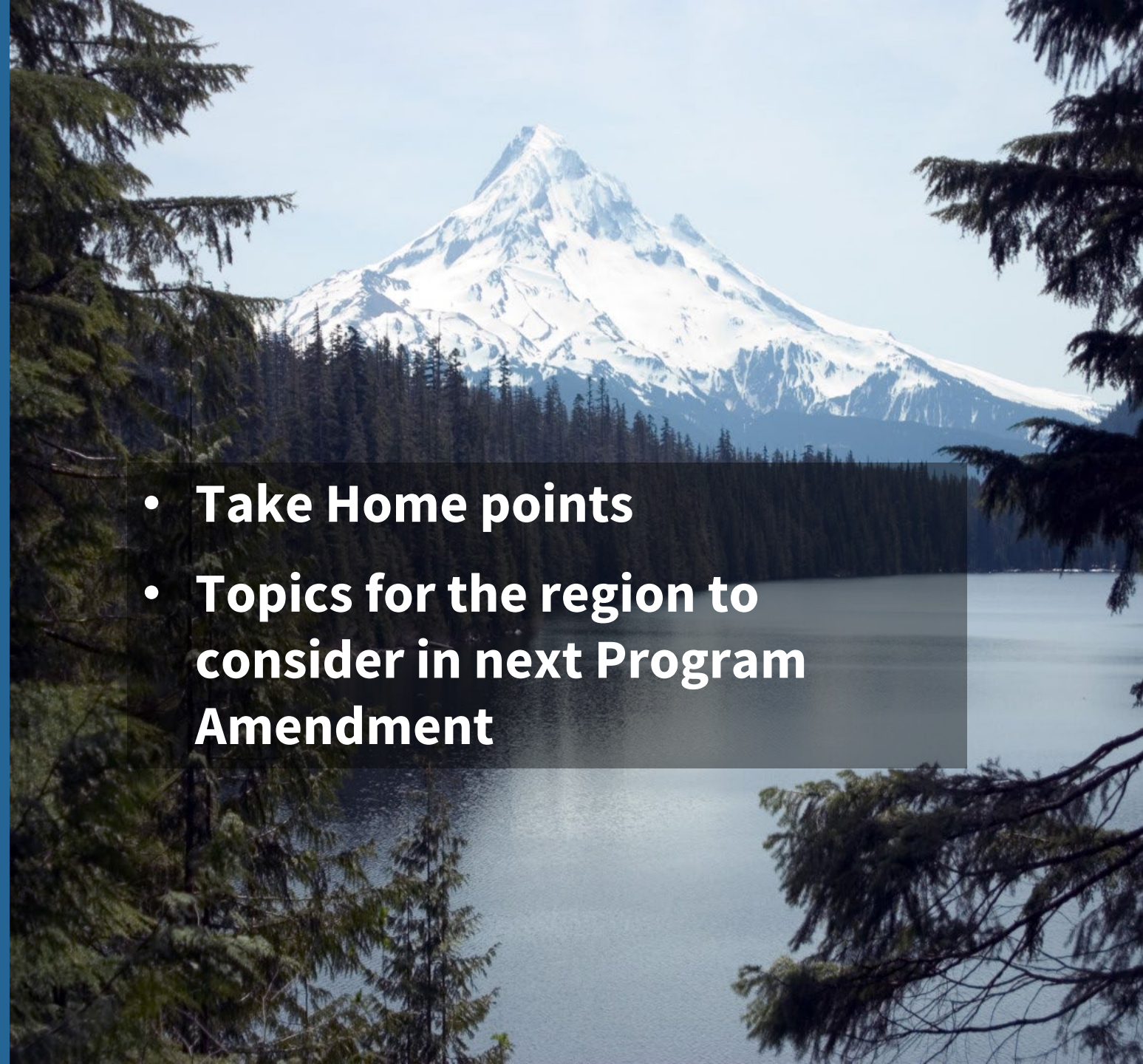
- Working to improve forecast models
- TMT now reviews May forecast at June meeting

Discussion

- Is there value in developing Integrated Rule Curves for other reservoirs?
  - Previously explored at Dworshak and Grand Coulee
  - Biological basis for balancing multiple operations in different water years
- How might implementation of operations at Libby and Hungry Horse be affected by new Columbia River Treaty?
- Are historical frequencies of normal and dry years changing? How does this affect operations?
- Are changes to runoff affecting water supply forecasts in other parts of the basin?

Outline

- Approach to Program Performance
- Components of Hydrosystem Categorical Assessment
- Description of select operations relative to Program measures
- **Discussion**



- **Take Home points**
- **Topics for the region to consider in next Program Amendment**

Take home points

Adaptive management

- Key to implementing hydro operations, given multiple priorities and environmental conditions
- Targets function as sideboards but actual implementation requires ongoing management decisions including in-season
- Programs have called for adaptive management from beginning, called for evaluation, identified who could participate, set up processes for coordination

Variable implementation

- Water management plans and BiOps contain priorities
  - (ex: reservoir refill vs seasonal flows)
- Program emphasizes implementing operations to benefit multiple fish species
- Not all operations are fully implemented as described in Program

Take home points

Challenges in implementation

- Changing environmental conditions (drought/ fire/ early runoff/ more precipitation as rain)
- Forecasting models (upon which all fish decisions rely)
- Aging infrastructure
- Balancing competing operations among fish species and authorizing purposes
- Increasing demand for power and water
- Evolving hydropower operations to meet needs of a changing power system

Improvements that have occurred

- Better modeling
- Lessons learned from 40 years of implementation
- Adaptive management systems established
- In-season operations refined

Discussion topics

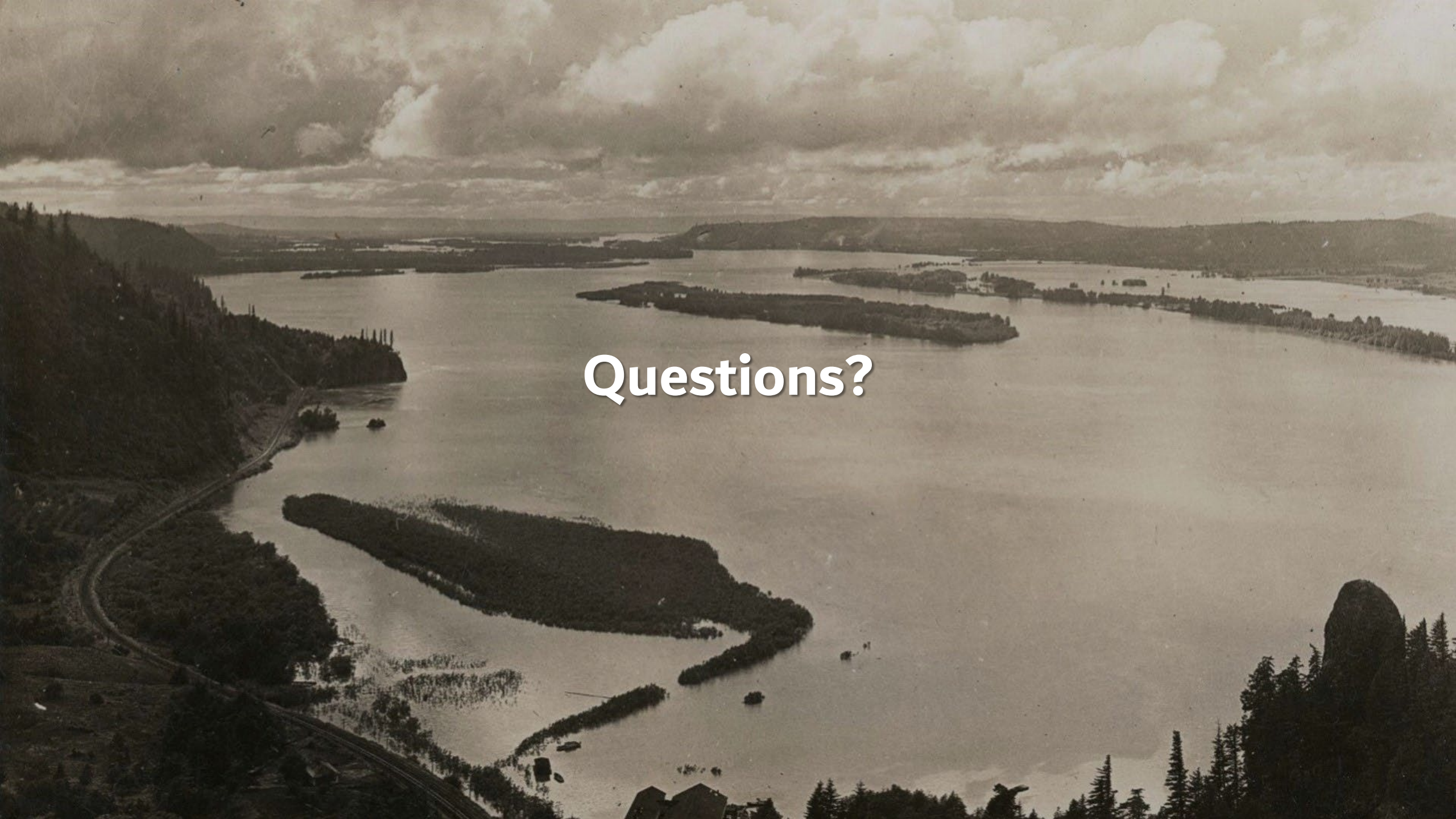
What do we need to think about leading up to the next amendment?

- Are there different or additional measures to consider prior to next Program?
- What does it mean that we have incomplete implementation? Are there missed opportunities? Is there language describing measures that needs to be updated to accurately reflect implementation?
- Are there changes in the type or priority of operations that should be addressed in the Program? How do we address the challenge of meeting varying objectives or needs?

As Basin priorities or conditions change, are operations adaptable?

- How will the balance of power and water be affected by things like climate change or human population shifts?
- How do we incorporate changing demands and operation of system?

  → Hydro flexibility and ramp rates; Columbia River Treaty; spill; Columbia Basin Restoration Initiative, BiOPs
- How are measures/goals incorporating or planning for future change or flexibility/ supporting system resilience?


Questions?