Water Engagement Initiative
TWG Update for MT Meeting #27

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Climate Change

- WEI considered CC since inception
- Active discussion at MT and TWG
- 5 “sub-committee” meetings w/ researchers

Climate Change

- Collaboration between various research groups
  - Multiple model approach using the most up to date methods and data
- Understand how local climate change will alter
  - Inflows to the Nechako Reservoir
  - Flows and temperatures in the Cheslatta-Nechako
- Update operations to mitigate the effects

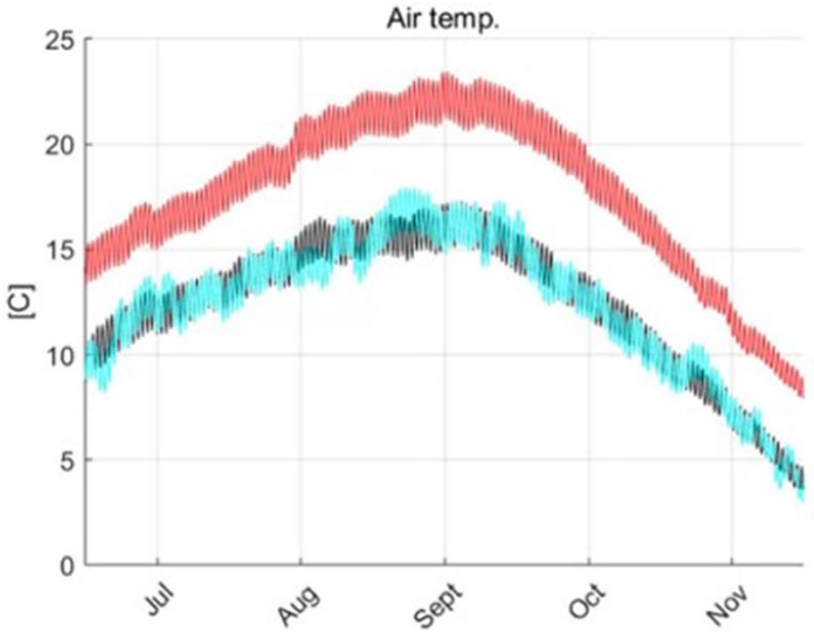
Climate Change

- Dr Richard Arsenault (ETS): predicted hydrological changes
- Dr Stephen Dery (UNBC): atmospheric and river temperature changes
- Dr Casey Beel (Ecofish): What does CC mean for WEI?

Climate Change

Discussion Ideas

- How do we incorporate CC research results into WEI?
- What data is needed?
- What timeframe?



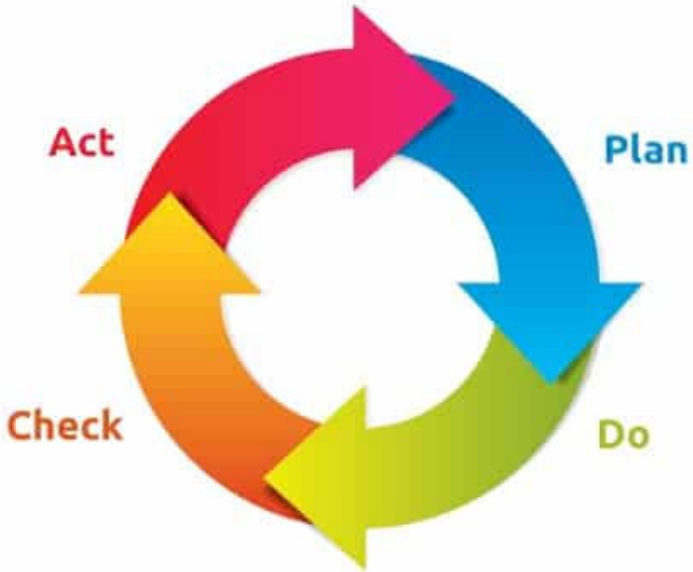
Climate Change

Approaches we can consider include:

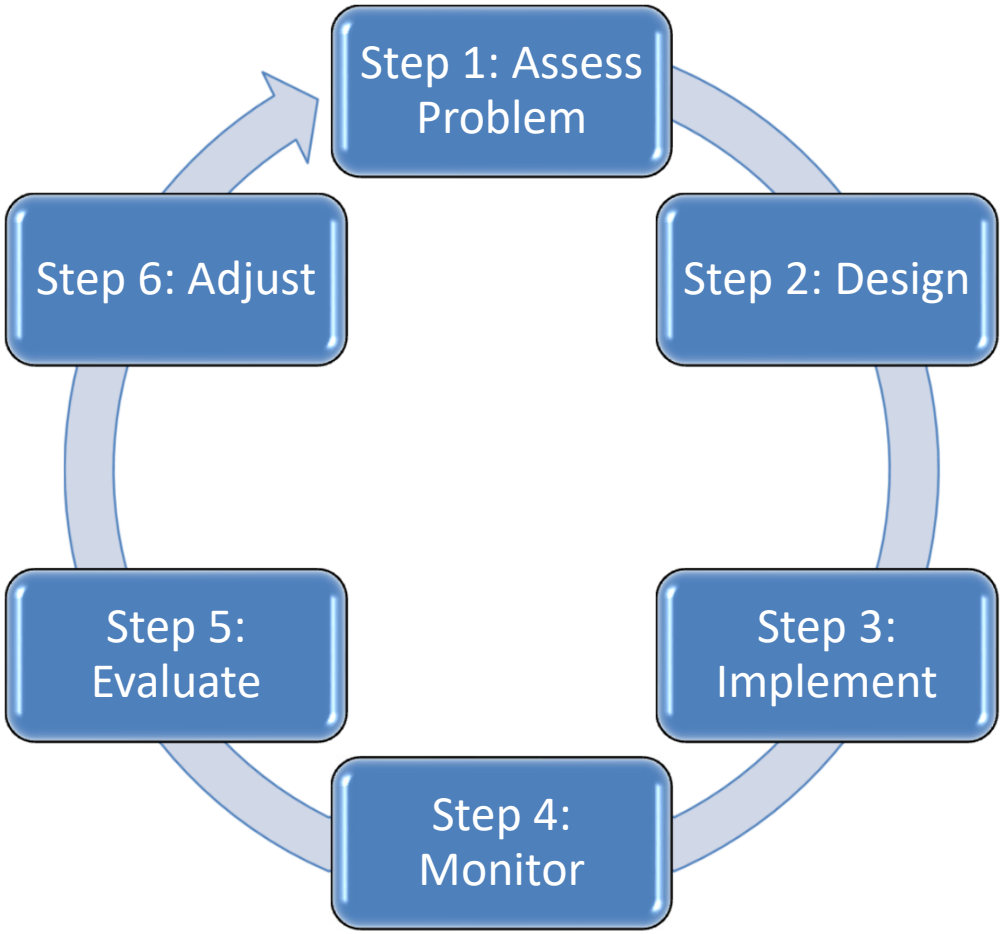
- Status quo (make our decisions based the historical hydrological record: 1950's to current).
- Choose a subset of the historical hydrological record to represent anticipated near-term conditions.
- Adopt CC research climate projections.
- Hybrid or alternative approach.

Adaptive Management

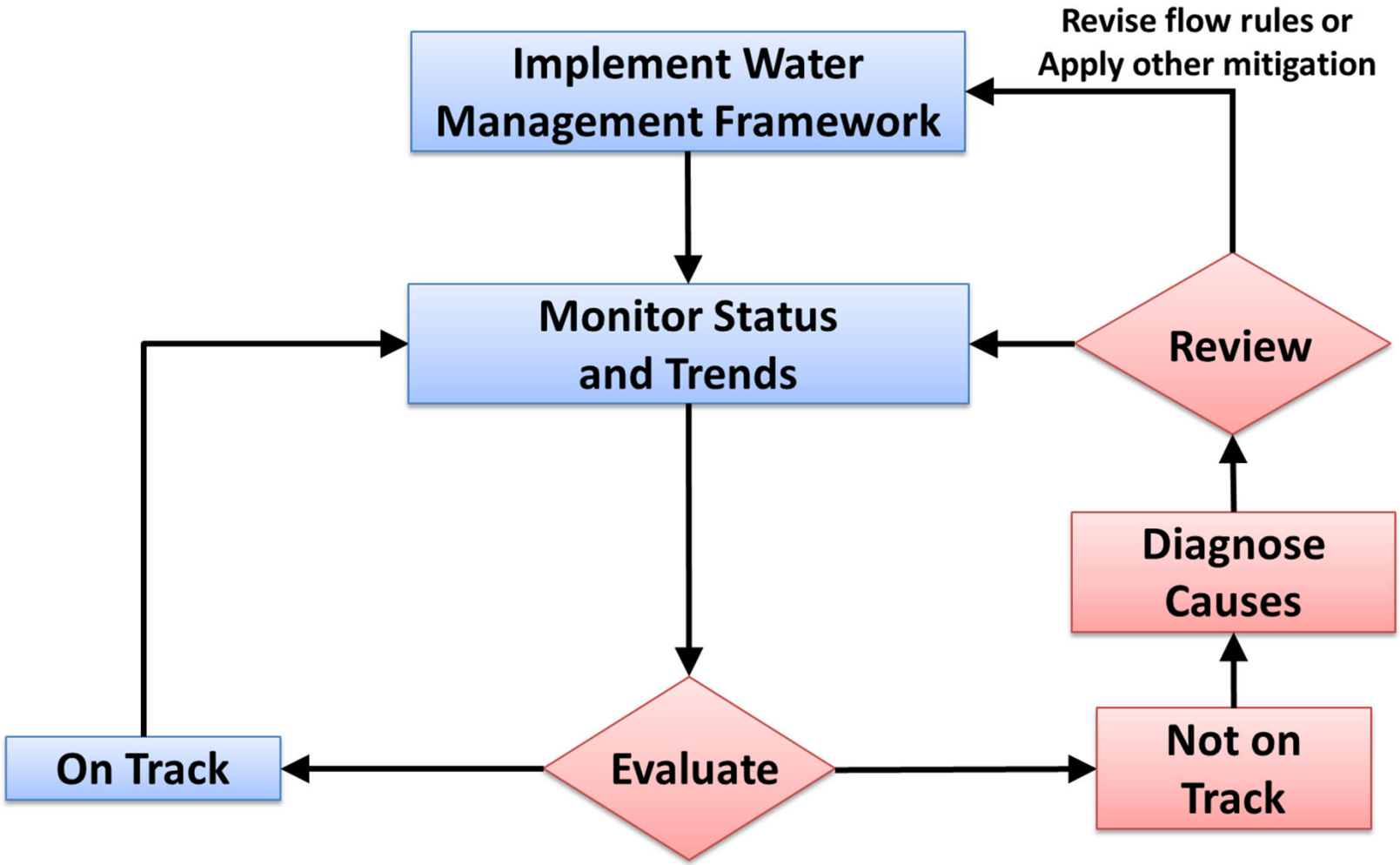
- Common theme through TWG work: data gaps, limited information, imprecise science
- How do we move forward with uncertainty?



Adaptive Management



Adaptive Management



Adaptive Management

- Passive
  - Assumes hypothesis is correct
  - Monitor results
- Active
  - Hypothesis uncertain
  - Experiments, flow trials

Sturgeon

Sturgeon

- WEI Technical memo
- Draft PM
- Other jurisdictions
- NWSRI

Sturgeon and Adaptive Management

(Goodman *et al.* 2012)

- Shovelnose Sturgeon in Missouri River tributary
- Study of experimental discharge levels on spawning behavior
  - 2006 and 2008; released 134 m^3/s and 18 m^3/s: sturgeon spawning
  - 2007 and 2009; released 14 m^3/s and 20 m^3/s: no sturgeon spawning
- Discharge ≥28 m3/s provides a spawning cue

Sturgeon

Adaptive management options

- Implement flow alternatives for other interests and monitor results on sturgeon (passive AM)
- Purposeful flow trials for sturgeon (active AM)
  - Collaboration between WEI and NWSRI to maximize benefits, minimize risk (including interruption to NWSRI research)

Issues Scoping & Performance Measures

Issues Scoping & Performance Measures

Interest	Pathway	Outcome
Communication & Process	Communication Working Group	New/Improved Communication
Social, Economic, & Environmental Receptors Fish & Wildlife Human Health Culture & Heritage Flooding & Erosion Recreation Rio Tinto Operations	Technical Working Group	Flow Changes Physical Works Monitoring Adaptive Management
Reservoir-specific	South-Side Working Group	Physical Works
Related Initiatives (not directly controlled by Rio Tinto	Non-WEI Processes (land use planning, climate change)	Inform WEI Adapt RT operations

Issues Scoping & Performance Measures

Fish & Wildlife
Human Health
Culture & Heritage
Flooding & Erosion
Recreation & Navigation
Rio Tinto Operations

↓

Develop Objectives & Performance Measures
(includes studies)

↓

Develop & Model Flow Alternatives

↓

Tradeoff Analysis

↓

Flow Change
Physical Works

↓

Monitoring & Adaptive Management

Issues Scoping & Performance Measures

- TWG tasked with Social, Economic, and Environmental receptors.
- Related to RT flow operations
- 69 issues to date
- TWG continues to scope 63 of these issues

Issues Scoping & Performance Measures

- SSWG tasked with 6 reservoir issues:
  - Water intakes
  - Bank erosion
  - Boat launches and docks
  - Navigation hazards: exposed trees
  - Navigation hazards: submerged rocks
  - Beach inundation

Issues Scoping & Performance Measures

TWG Pathway Interests

Yes

Scoping
1) Summarize background information
2) Define and contextualize issue:
-timing
-location
-magnitude, duration, consequence
3) Identify pathway of effect
4) Propose pathway

SDM pathway

PM development
1) Gather information to develop performance measures

2) Sensitive over operational water level/flow range?

Yes

Develop specific PM

SDM pathway

Reject issue

Interest is not an issue

Alternative pathway

Physical works or other

Insufficient info

Flag as data gap

Additional studies

Redundant or insufficient info

Adopt proxy PM

No

Either a non-issue or identify alternative solution

Issues Scoping & Performance Measures

- TWG issues scoping can include:
  - Information reviews
  - Data analysis
  - Field surveys
  - Professional opinion.
- Scoping results: technical memos, scoping document

Issues Scoping & Performance Measures

Technical memos

- Completed by subject matter experts
- Summary of existing information
- Assessment & analysis

Issues Scoping & Performance Measures

2021 Memos (8)	Number of issues (19)
Wetlands	1
Reservoir productivity	2
Entrainment SLS	1
Entrainment Kemano	1
Caribou	3
Reservoir Wildlife	9
Water temp and salmon	2
Ramping	1

Issues Scoping & Performance Measures

2022 Memos (16)	Number of issues (35)
Chinook Salmon	4
River Resident Fish	2
Sturgeon	2
River Wildlife	3*
River Temp Resident Fish	1
Reservoir Productivity #2	2
Murray-Cheslatta Productivity	2
River Productivity	2
River Access to Tribs and Sidechannels	2
Reservoir Access to Tribs	2
Salmon Escapement	1
River Flooding and Erosion	7
Mussels	1
Murray-Cheslatta Fish Habitat	1
Murray-Cheslatta Bank Erosion	1
Total Dissolved Gas	2

Issues Scoping & Performance Measures

- Most of the 63 issues are sensitive to RT operations
  - Suitable for flow alternatives and SDM
  - TWG has developed draft performance measures)
- Some issues with uncertainty
  - Ongoing technical work
- Some issues are insensitive to RT operations.
  - Not suitable for SDM, but some have other options

Issues Scoping & Performance Measures (insensitive issues)

Methylmercury (Issue #49)

- Common in reservoirs; caused by initial flooding (not annual operations) and subsequent decay of vegetation.
- Diminishes with time.
- No indication of high MeHg in Nechako reservoir basins.
- No further action suggested.

Issues Scoping & Performance Measures (insensitive issues)

Osprey nesting (#38)

- Nest on dead-standing trees.
- Nesting within the reservoir is unique to Nechako, but abundant nest sites outside reservoir.
- Relatively insensitive to range of RT operations.
- No further action suggested.


GET INVOLVED NECHAKO
Rio Tinto

Issues Scoping & Performance Measures (insensitive issues)

<u>Reservoir woody debris interfering with ungulate migration (#31, 35)</u>

- Confirmed issue for caribou (same mechanism for moose): woody debris accumulates along shoreline and blocks travel.
- Woody debris accumulation relatively insensitive to range of RT operations.
- Good candidate for physical works (i.e., debris removal) at priority sites.


GET INVOLVED NECHAKO
Rio Tinto

Issues Scoping & Performance Measures (data gaps)

- Total Gas Pressure (TGP) (#1)
- Reed canary grass (#5, 8)
- Freshwater mussels (#27)
- White sturgeon (#28, 29)
- Groundwater flooding (#54)
- Sediment transport (#57)
- Fraser Lake backwatering (#58)

Issues Scoping & Performance Measures

Issues that are sensitive to RT operations

- All other issues
- TWG recommending these issues for consideration in developing flow alternatives and informing structured decision making
- TWG draft performance measure

Issues Scoping & Performance Measures

Performance measures

- An approach to quantify how an issue responds to a flow alternative
- Allow us to evaluate between issues and flow alternatives
- Rely on sensitivity to flow/level
- Not always linear or intuitive
- Need to consider modeling
  - Locations
  - Time series
  - Precision/accuracy

Draft Issues Scoping Table

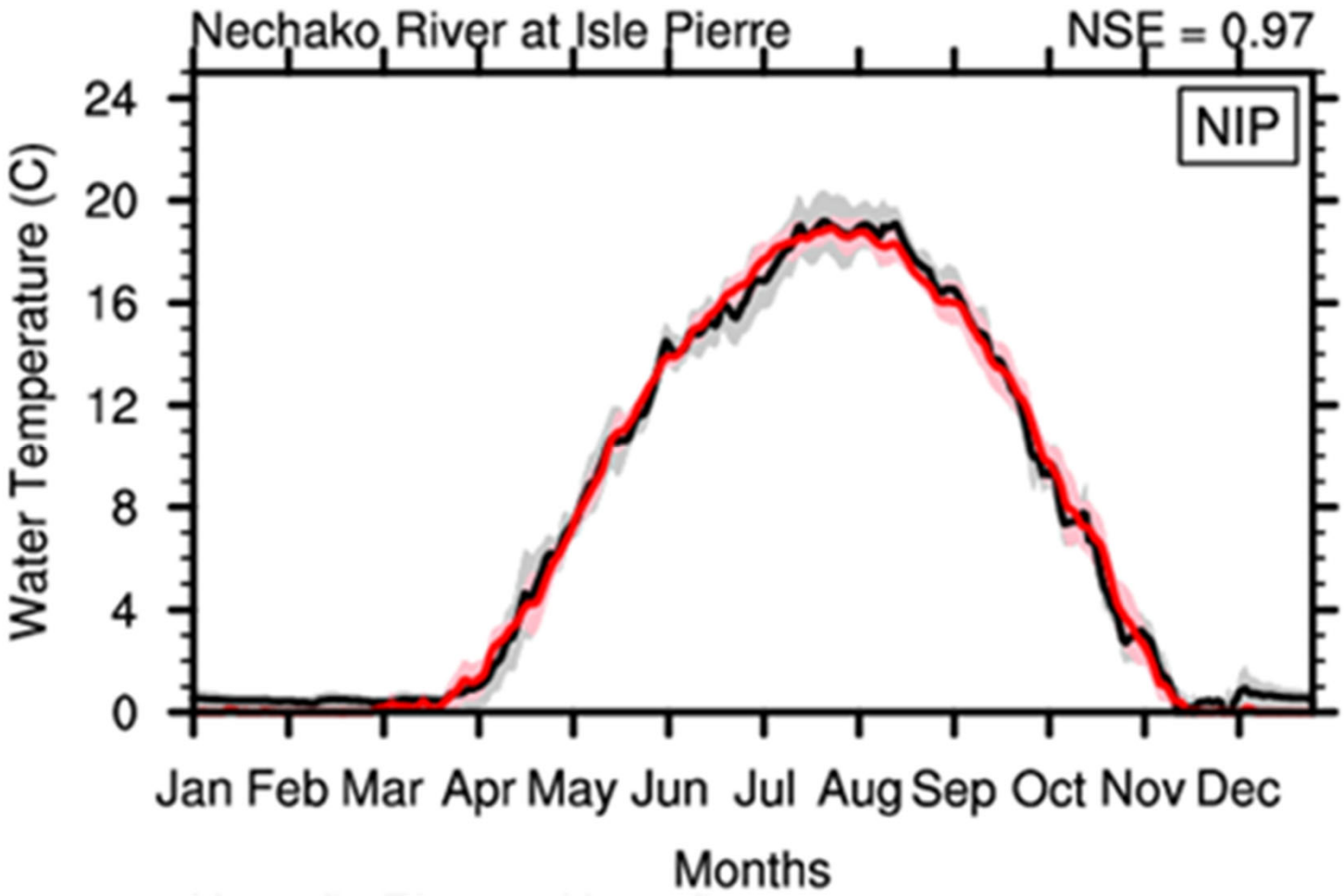
Interests	Issue Name	Issue Number	Data Gap for Technical Memo or PM	PM Target	PM Location	PM Timing	Performance Measure (for Bookend Alternatives)	Performance Measure Comment	TWG Comments
Resident fish habitat; Resident fish species (habitat, flows, temperature)	TGP	1	no data since 2005 and for upper flow range (>290cms). Data collection requires late summer (possibly spring) field trip. Uncertain whether this is needed for memo or PM.	All species and life stages, focus on juvenile salmonids. Rainbow trout and sucker species are the most sensitive species to TDG.	downstream of SLS and Cheslatta falls	TGP can happen year-round, but primary during spring freshet and summer STMP flows.	none (monitoring trigger)		TGP likely not to be a major decision point for this Projec, but data gap at high flows. Suggest we have as trigger for monitoring rather than PM. Likely at least partially addressed by flooding PMs
Fish access into tributaries; Kokanee spawning habitat access	River fish access to tributaries	2	no field data for vast majority of tribs. Can assess using satellite imagery/DEM, but unsure if sufficient resolution.	All species, focus on: RB (adult) CH (fry)	Entire Nechako River	RB: CH: late spring/early summer	average flow (more is better)		alternatives: # of days where streams are accessible # of tribs with sufficient depth
	Reservoir fish access to tributaries	3	no field data for vast majority of tribs. Can assess using LiDAR/DEM, but unsure if sufficient resolution.	Kokanee Rainbow Trout Mountain Whitefish	Nechako Reservoir	RB Spring KO: fall	average water elevation (higher is better)		
Fish stranding	Flow ramping	4	lack of data for Cheslatta River; no fish stranding studies complete	All fish	Murray-Cheslatta and Nechako River	July 1 to September 30	change in stage (3 day data) (less is better)	daily data would be better (but model output is 3 days). Compare 3 day model output to historical data to determine	For BC Hydro WUPs, ramping was not used as a PM, but rather included as an operational rule afterwards. Dan Sneep suggested we propose this as
	River reed canary grass - fish stranding	5	No data on Nechako distribution, abundance, stranding effects.	tbd	tbd	tbd	no specific PM: default to river ramping criteria Issue #4		Reed canary grass less important for stranding than general impact on habitat (#8)
Side/off channel	River fish access to side/off channels	6	Few reports. analysis would rely on DEM or MAD-assumptions of wetted width	Chinook juveniles Sturgeon Rainbow Trout	Murray-Cheslatta and Nechako River	year round, but primarily growing season	median flow (more is better)		Can we identify a flow threshold? Wetted area could be used as the PM, if we had a really good hydrodynamic model – that would be the ideal PM. Look at number of side-channels that are wetted at any given time as PM
Side/Off channels; Riparian restoration or enhancement	River functional riparian and side/off channel habitat	7		all species	Entire Nechako River	year round, but primarily growing season	average flow during growing season as percent of MAD	Scale PM to MAD to show differences between alterantives. Need to consider whether this Is this pre- or post-diversion MAD	
Invasive species and fish habitat	River reed canary grass - invasive spp/habitat impacts	8	No data on Nechako distribution, abundance, habitat effects.	all species	Entire Nechako River	year round, but primarily growing season	defer until tech memo completed after bookend exercise		We don't know enough about reed canary grass to develop a draft PM. May be insensitive to flow throughout the range of operations.
River productivity	River productivity	9	Information regarding productivity (e.g., periphyton, invertebrates) in Nechako River has yet to be reviewed or does not exist.	All species	Nechako River	Year round, but primarily growing season	use flow-productivity curve	Suggest flow-productivity curve from proxy stream seems more intuitive than KCP curve Upper Lillooet curve - similar freshet magnitude as Nechako Forrest-Kerr (similar MAD as Nechako).	Invertebrate suitability curve as shown during the presentation is a perfect dataset to develop a PM Will be critical to identify what the limiting factor for productivity is.

Issues Scoping & Performance Measures (sensitive issues)

Salmon migration temperature (#18)

- Good data
- Sockeye salmon migrating through lower/mid Nechako River
- Early July through September
- PMs: # of days average daily temp exceeds 18C, 19C, 20C at Vanderhoof (fewer is better)

Issues Scoping & Performance Measures (sensitive issues)



Issues Scoping & Performance Measures (sensitive issues)

Caribou land links (#32)

- Good data
- Calving islands in Whitesail Reach can be connected to mainland at low reservoir level
- May through early July
- PM: # of days water elevation is > 852 m (more is better)

Issues Scoping & Performance Measures (sensitive issues)

River Erosion (#52, 56)

- Limited data
- Numerous locations in Cheslatta and Nechako River
- Year-round, freshet and STMP most sensitive
- PMs:
    - # of days flow exceed mean annual discharge (fewer is better)
    - # maximum instantaneous discharge (lower is better)

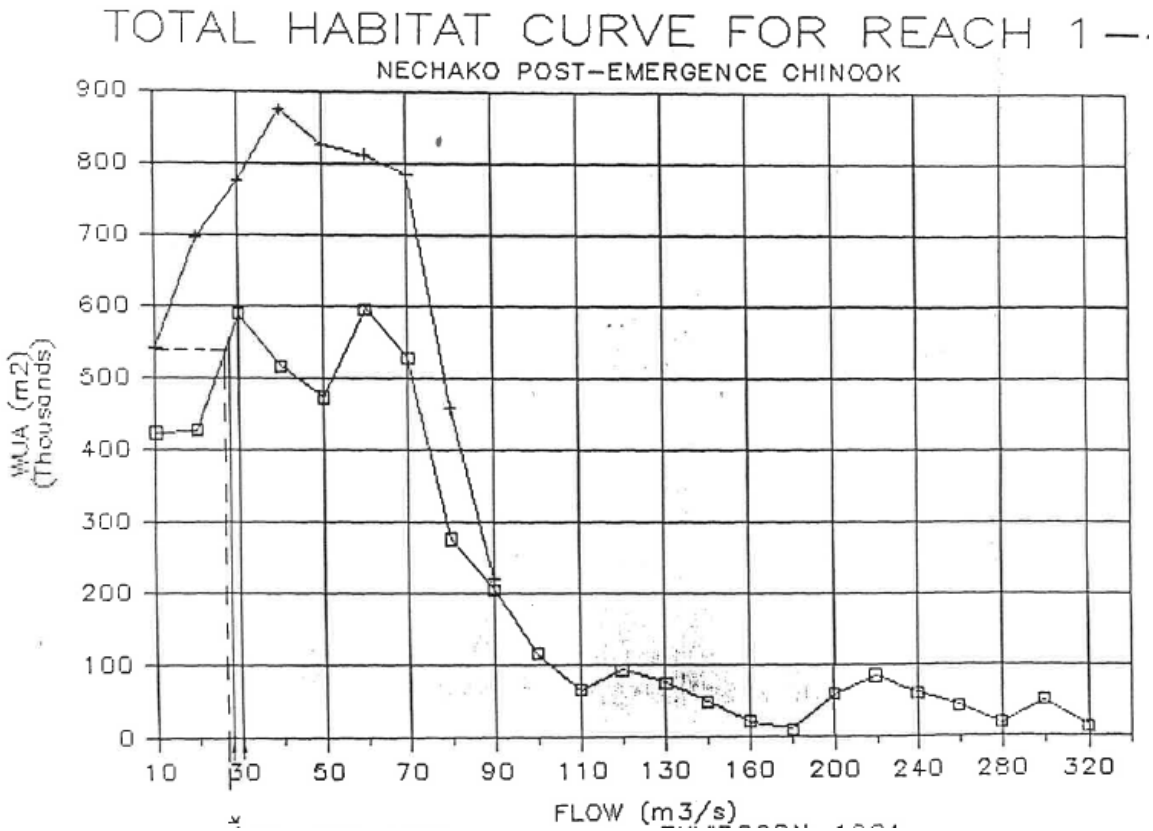
Issues Scoping & Performance Measures (sensitive issues)

<u>Chinook salmon early rearing habitat (#22)</u>

- Good data
- Nechako River, Chelslatta falls - Vanderhoof
- Late winter – early spring
- PM: # of days where flow <70cms at Cheslatta falls (post-emergence period only) (more is better)
- PM based on flow-habitat curve

Issues Scoping & Performance Measures (sensitive issues)

Chinook salmon early rearing habitat (#22)



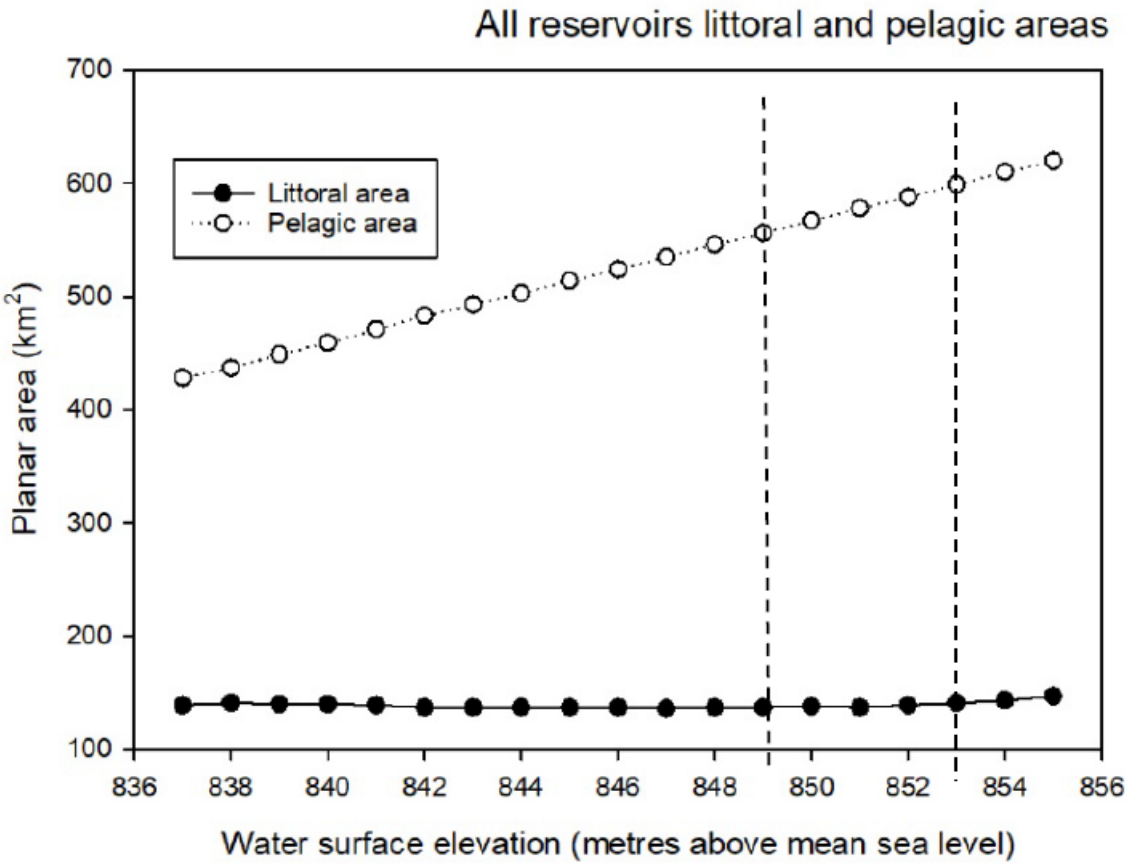
Issues Scoping & Performance Measures (sensitive issues)

<u>Reservoir productivity – habitat (#13)</u>

- Limited data
- Nechako Reservoir,
- Year-round
- PM:
  - annual pelagic habitat (more is better)
  - Based on Nechako Reservoir habitat curve

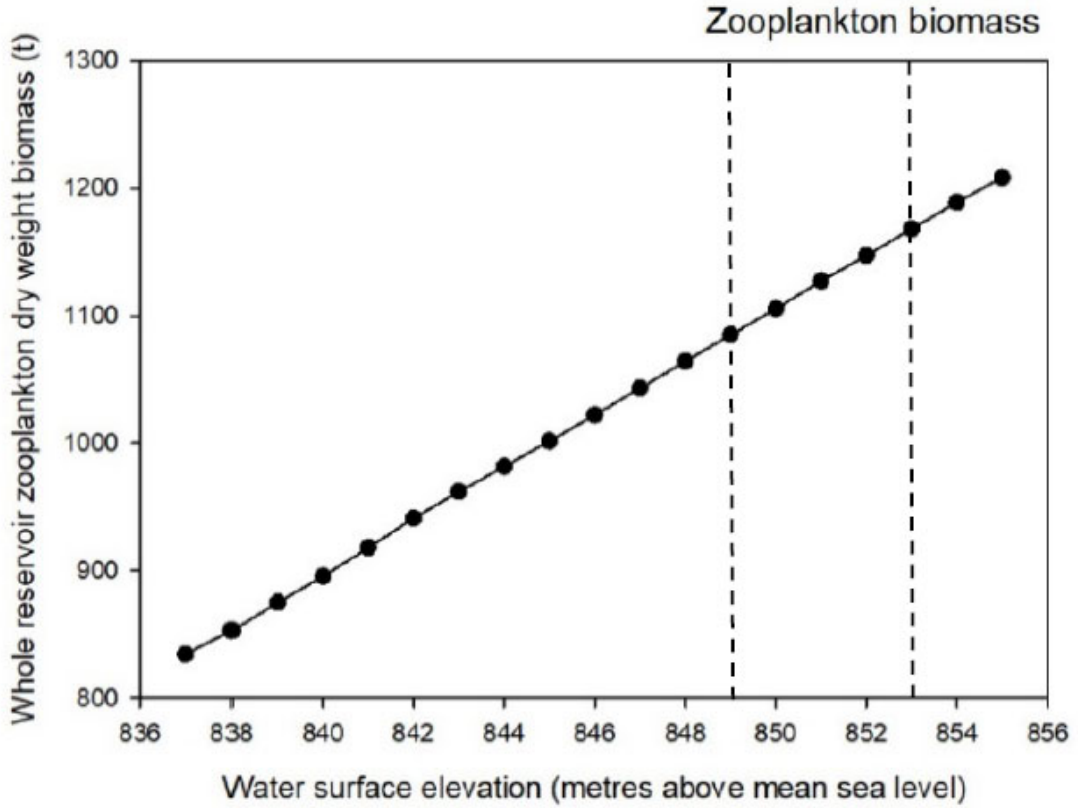
Issues Scoping & Performance Measures (sensitive issues)

Reservoir productivity – habitat (#13)



Issues Scoping & Performance Measures (sensitive issues)

Reservoir productivity – zooplankton (#13)



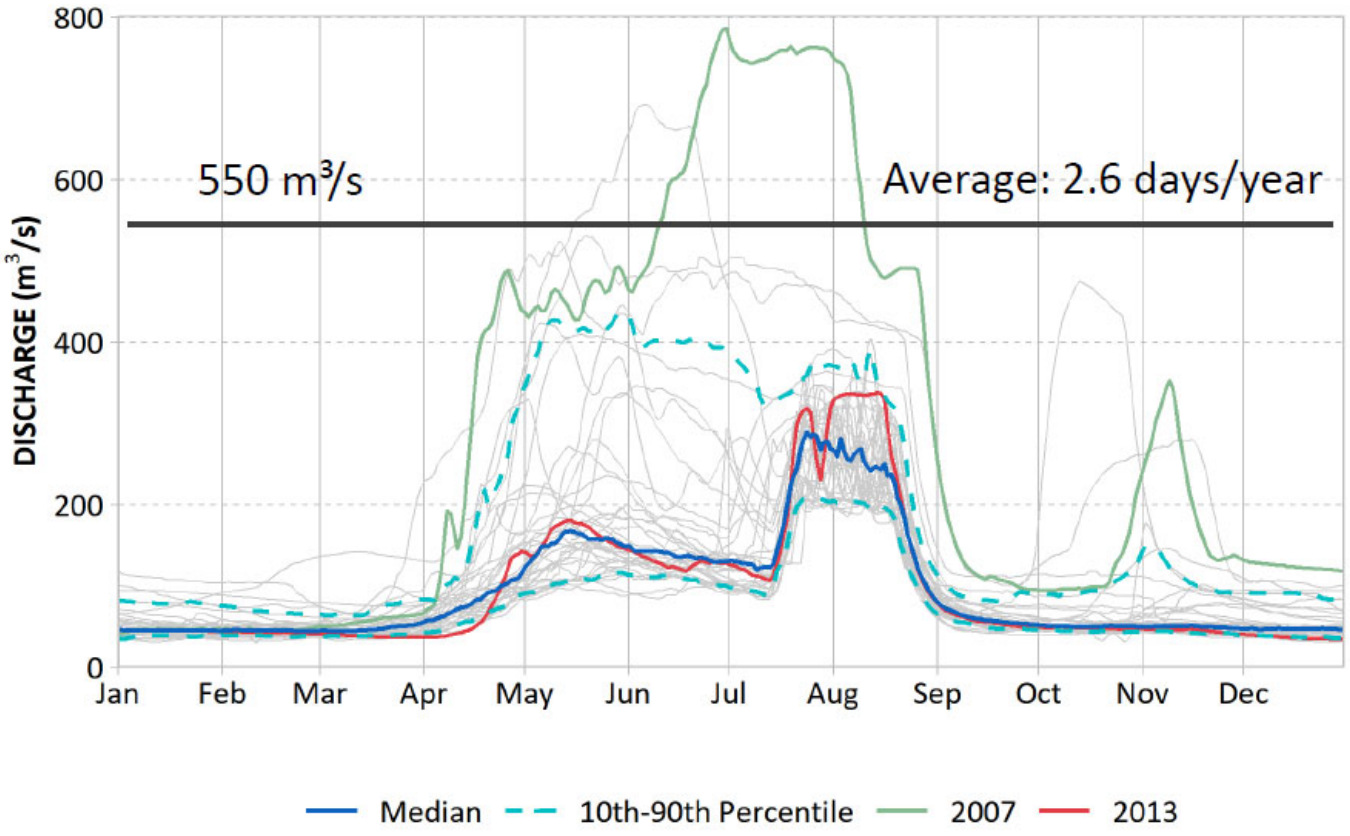
Issues Scoping & Performance Measures (sensitive issues)

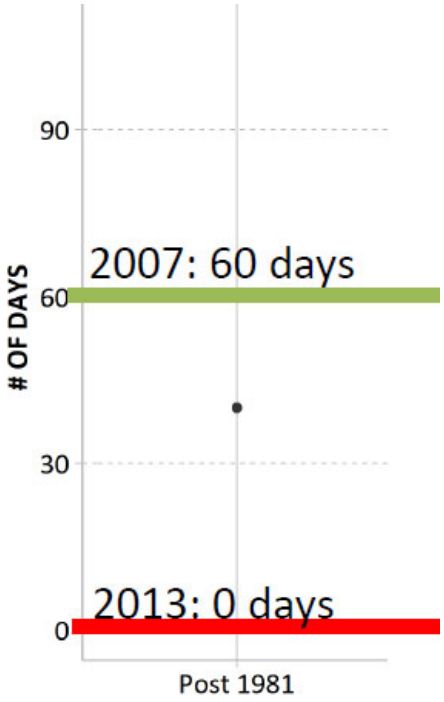
Vanderhoof flooding (#53)

- Good data
- Vanderhoof, Sandy-Beach subdivision
- Year-round, freshet and STMP most sensitive
- PM: # of days flow >550 m^3/s at Vanderhoof (fewer is better)

Issues Scoping & Performance Measures (sensitive issues)

Vanderhoof flooding (#53)





Issues Scoping & Performance Measures (sensitive issues)

Fish access to tributaries (#2,3)

- Limited data
- Nechako River, Reservoir,
- Year-round, timing specific to species
- PM: average water elevation/flow (higher is better)

Issues Scoping & Performance Measures (sensitive issues)

River sidechannels (#6, 7)

- Limited data
- Nechako River
- Year-round, likely most sensitive during growing season
- PMs:
    - median flow (more is better)
    - average flow scaled to MAD (more is better)

Bookend Flow Alternatives

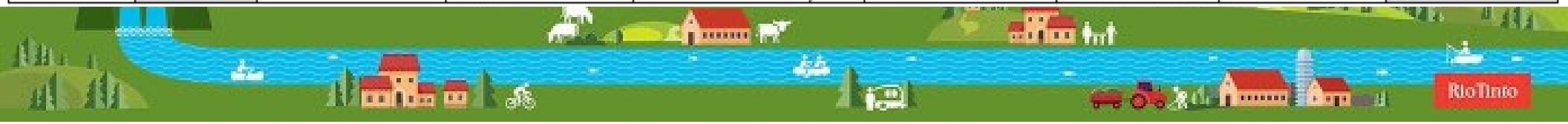
- Purposefully maximize individual interests.
- Not proposed as realistic alternatives to actually implement.
- Designed to learn from.

Bookend Alternatives

Structure and Sequencing of WEI Flow Alternatives			
	Phase 1 – Alternatives	**Phase 2 – Alternatives**	**Phase 3 – Alternatives**
Description	Flow alternatives that Rio Tinto could unilaterally make within the immediate term (e.g., next calendar year) with notification to regulators, First Nations and stakeholders with time to undertake any internal assessments that may need to be carried out *(i.e., changes are permitted within their current authorized operations)*	Flow alternatives that would require Rio Tinto to seek some form of approval / authorization(s) according to their existing water license and/or flow related agreements and/or commitments with First Nations.	Combination of new water management facilities (mitigation / enhancement projects) and potential changes to flow releases to the Nechako River to maintain and/or improve conditions related to key water uses.
Approx Implementation Timeline (once decided, how long to implement changes)	**0-2 years** Could be implemented once any needed assessments and/or notifications are completed	**2 to 4 years** Could be implemented once any needed assessments, approvals and any consultations are completed.	**4 to 7+ years** Depends on the project and the corresponding approval process requirements, but generally these are likely implementable in the medium term based on necessary approvals, EAs, and consultation requirements being carried out.
Examples	• *Re-distributing the current AWA across the monthly flow releases from SLS (e.g., more naturalized, increase min base flows)* • *Changing ramping rates (e.g., at end of STMP)* • *Note. Proposed changes would be within the current water budget for the Nechako River*	• *Changes to the STMP flow release schedule and/or cooling targets.* • *Changes to current min or max monthly flow targets that have been agreed to from SLS (e.g., above AWA budget).* • *Establish flow targets at different downstream points on the system (e.g., Nechako River)*	• *Water release facility at Kenney Dam* • *Options for increasing flexibility of reservoir management* • *New flow release schedule at SLS and at any new release structure.* • *Other non-flow mitigation works to address water management impacts from the facilities*

Phase 1 – Draft & Illustrative Bookend Flow Alternatives (developed through TWG)

	Altern 1	Altern 2	Altern 3	Altern 4	Altern 5	Altern 6	Altern 7	Reference (Unregulated Flows)
Primary Purpose	**Status Quo** To serve as a reference to explore the benefits and costs of making flow changes	**Nechako River** **Aquatic Species & Ecosystems** *Provide a more naturalized hydrograph ("freshet") to promote ecosystem functions that benefit a range of aquatic species*	**Nechako River** **Sockeye** *Lower STMP temperature targets (18°c or 19°c) for sockeye migration*	**Murray-Cheslatta** **Aquatic Species & Ecosystems** *Provide a more naturalized hydrograph (i.e., reduce flow variability, especially through STMP) to promote ecosystem functions that benefit a range of aquatic species.*	**Reservoir** **Wildlife** *Minimize flooding of bird nests.*	**Reservoir** **Aquatic Species & Ecosystems** *Maximize reservoir productivity*	**Murray-Cheslatta & Nechako River** **Flood Mitigation** *Minimize flooding of Cheslatta gravesites.* *Minimize overland flooding at Vanderhoof*	To better understand hydrology and the context of the current water control facilities
Base Flow Condition	Status Quo	status quo for smelter, tier 1 power sales, AWA, STMP, SLS min flow, and physical infrastructure (i.e., max/min reservoir elevations). All other constraints can be altered (flooding, tier 2 power sales, ice jam, beavers etc.)						*Ecofish naturalized flow hydrograph*
Operational Changes / Targets	None	The flow timing will follow the Ecofish naturalized flow hydrograph, scaled to the annual volume of water that is available (including additional volume from current tier 2 power sales). This will result in more flow May-July, will maintain flows in the STMP period, and possibly result in lower flow at other times of the year.	There are two options to achieve this: • Maximize spillway release July 20 to Aug 20 (and see how cool we can reach) • Target 18 and 19C by releasing known volume of water (based on Alec's temp/flow modeling) This will result in more flow during mid-July to mid-Aug, and less flow at other times of the year.	Ramping rates (how fast flow increases/decreases) would be applied to the STMP period. Maximum flow for individual STMP events will not change, but the events will start sooner and end later, resulting in more volume to reach the same temperature compared to status quo. To provide a more natural-shaped hydrograph, high flows will continue to be released on the decline of freshet, leading into the STMP. The flow reduction following the STMP will be more gradual. This will result in a longer freshet, similar magnitude but longer duration STMP flow pulses, and less flow at other times of the year.	Minimize reservoir level increases during bird breeding season (April 15 – Aug 15). There are two options to achieve this: • Hold reservoir steady during bird breeding season (prevent nest flooding) • Reach full pool prior to bird breeding season (prevent bird nesting) Assuming the latter, this will result in and higher flow during freshet and lower flow during the fall and winter.	Maximize reservoir elevation during the growing season (May – Sept) This will require filling the reservoir as fast as possible in the spring and will result in lower flow during the initial onset of freshet, until the reservoir is full. When the reservoir is full, flow will likely increase for the duration of freshet.	Hard constraint of 300cms maximum at Cheslatta falls This will require lower reservoir elevations during winter/spring, resulting in higher river flow during this period and lower flow during the freshet (i.e., more stable flow to Nechako River).	*Ecofish naturalized flow hydrograph.* *This scenario will route all water through Skins Lake Spillway (no discharge through Kemano) resulting in more water in the Nechako River year-round.*

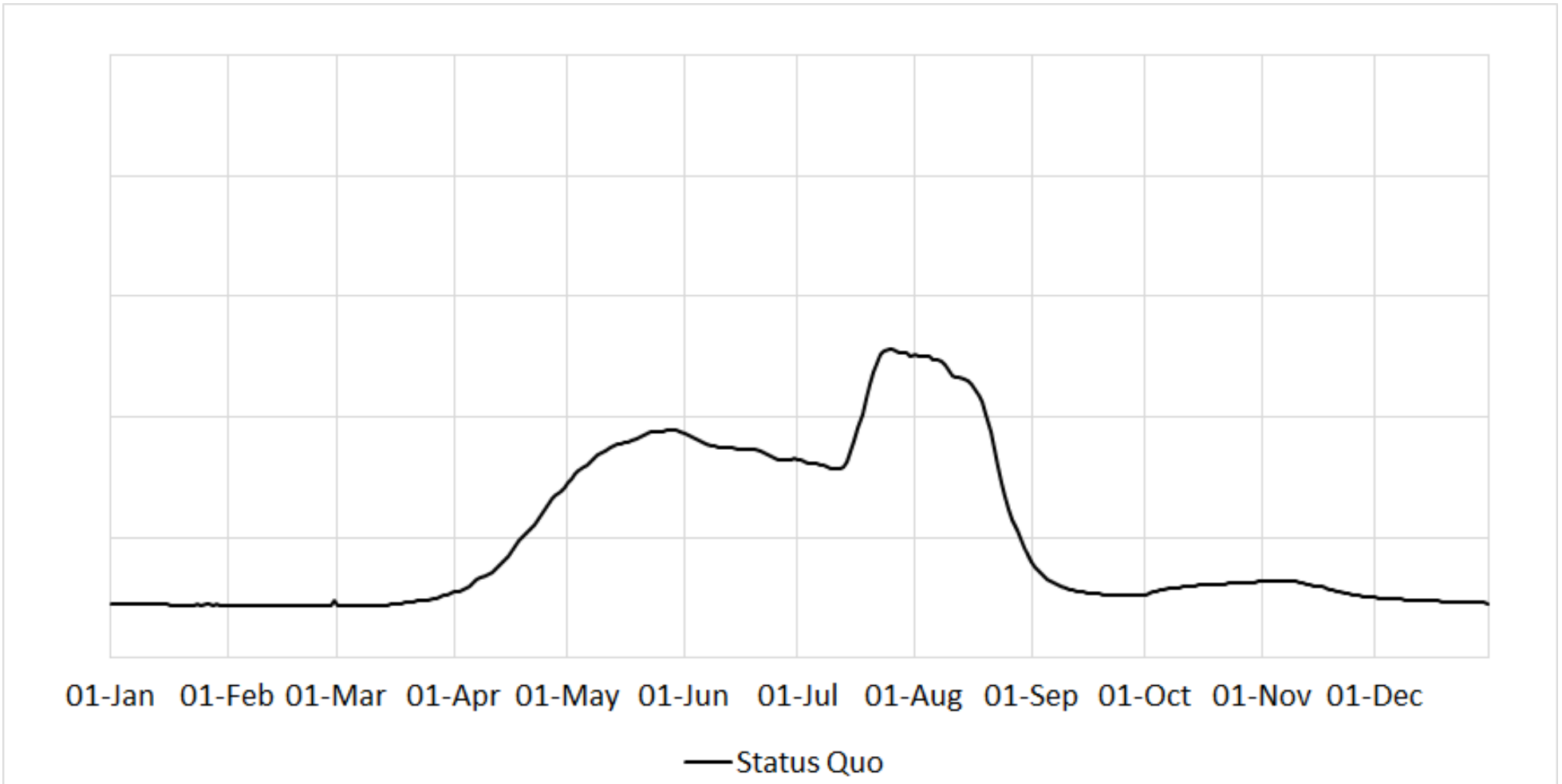


Bookend Flow Alternatives

<u>Alt 1 – Status Quo</u>

- Reference to explore costs and benefits of making change from current operations

Bookend Flow Alternatives – Alt 1



Bookend Flow Alternatives

Base flow conditions

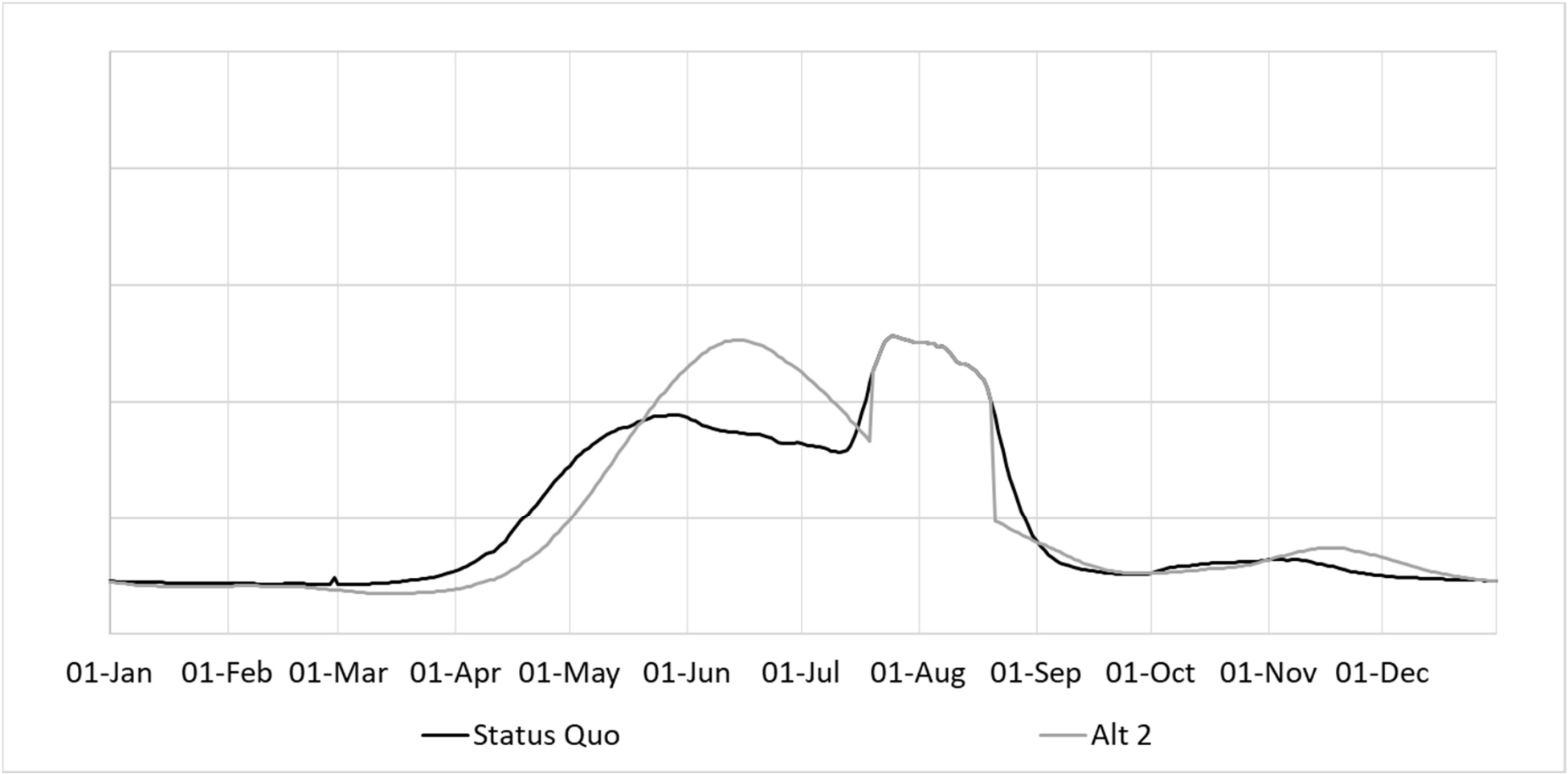
- No changes to flows to power the smelter and BC Hydro Tier 1 power sales, meeting flow requirements of Annual Water Allocation (AWA, chinook salmon flows), STMP flows for max river temperature, and maintaining minimum SLS release.
- Using existing infrastructure (SLS release, min and max reservoir elevations).
- All other constraints can be altered (tier 2 power sales, flooding risk, ice jam, beavers etc.)

Bookend Flow Alternatives

<u>Alt 2 – Nechako River Aquatic Species & Ecosystems</u>

- More naturalized hydrograph (“freshet”) to promote ecosystem functions that benefit a range of aquatic species.
- Scaled to the annual volume of water that is available
- More flow May-July, will maintain flows in the STMP period, and possibly result in lower flow at other times of the year.

Bookend Flow Alternatives – Alt 2

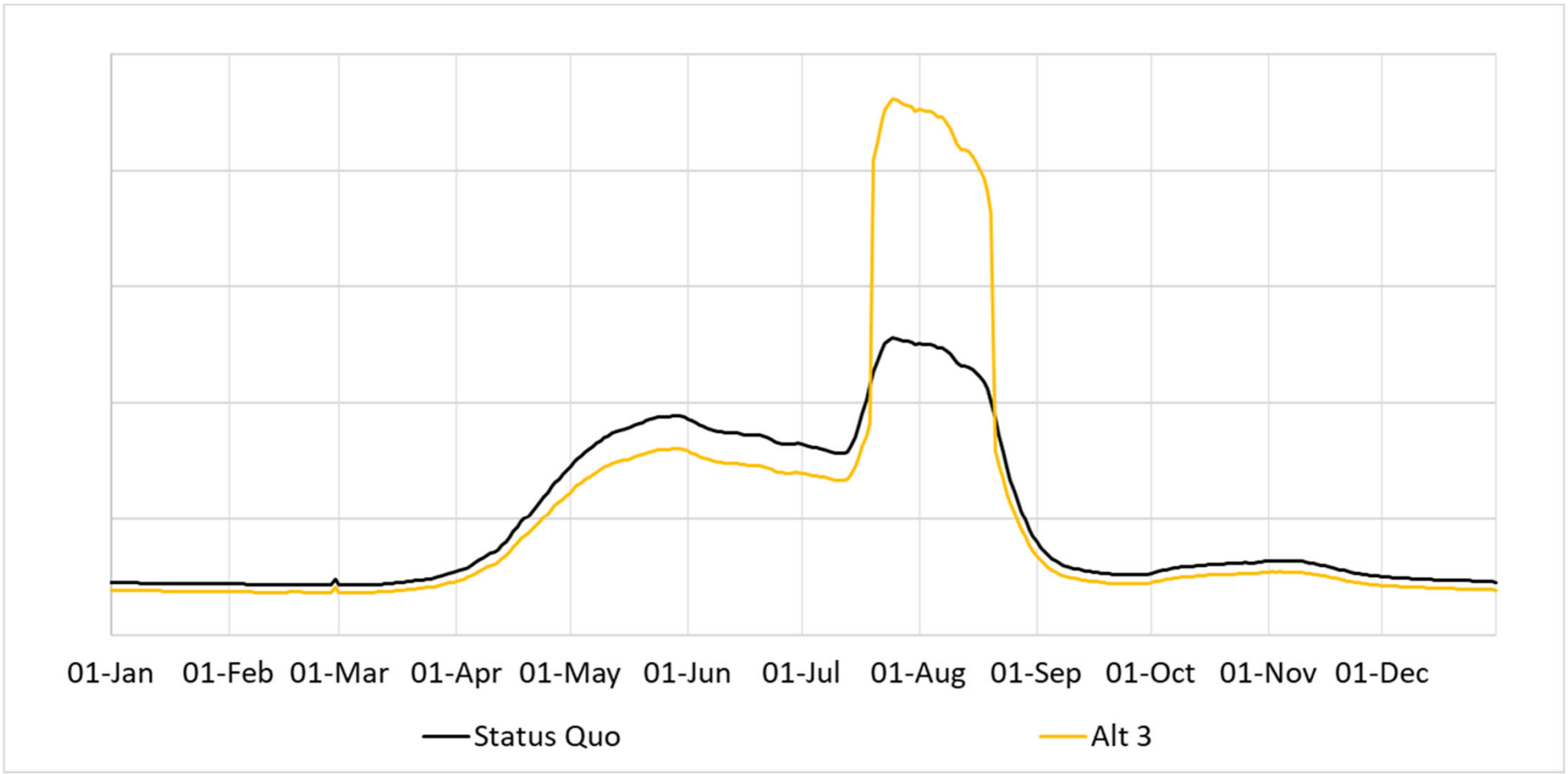


Bookend Flow Alternatives

Alt 3 – Nechako River Sockeye Salmon

- Lower STMP temperature targets (18°c or 19°c) for sockeye migration. 2 approaches:
  - Maximize spillway release July 20 to Aug 20 (and see how cool we can reach)
  - Target 18 and 19C (by releasing known volume of water)
- More flow during mid-July to mid-Aug, and less flow at other times of the year.

Bookend Flow Alternatives – Alt 3

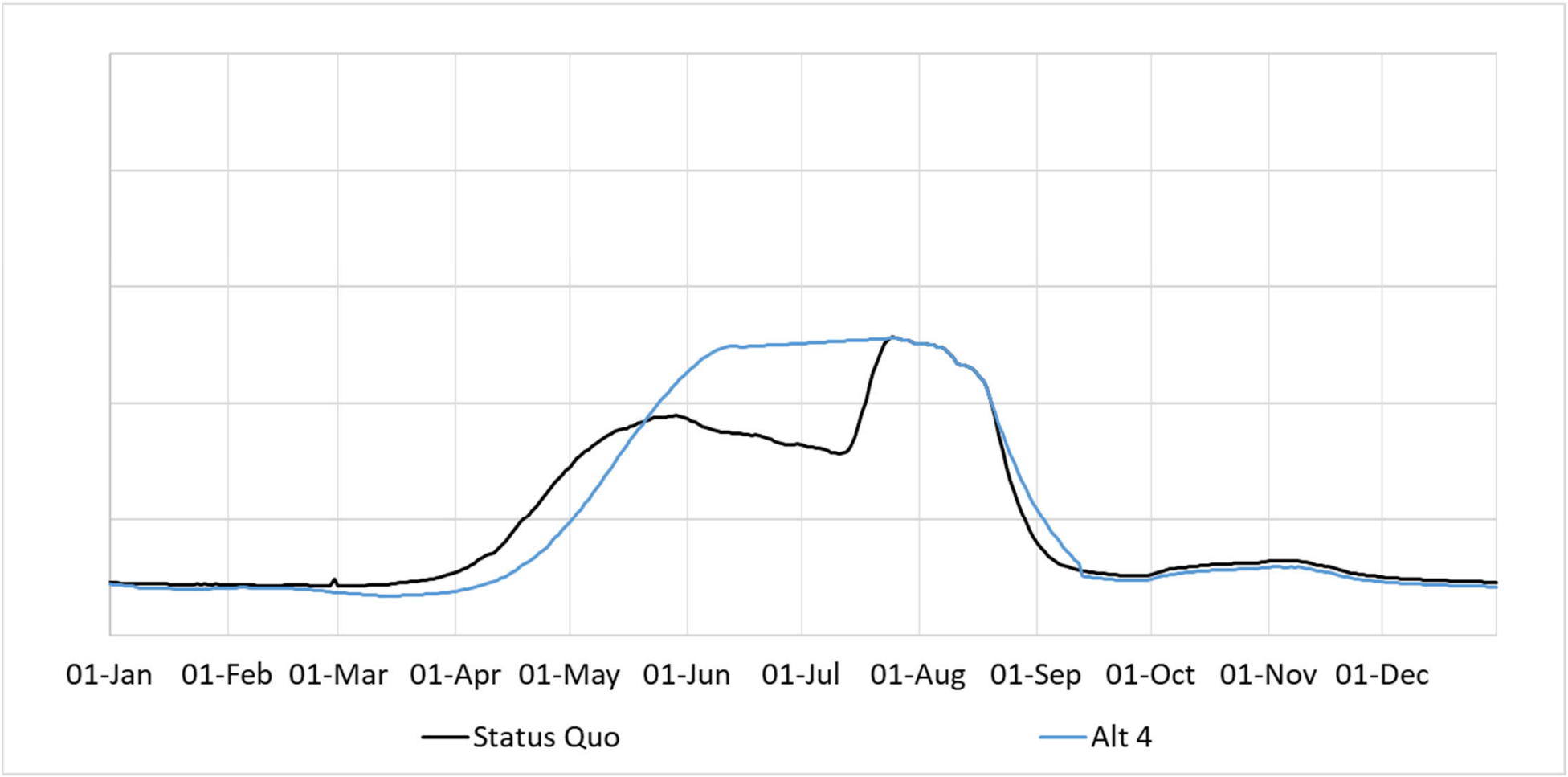


Bookend Flow Alternatives

<u>Alt 4 – Murray/ Cheslatta Aquatic Species & Ecosystems</u>

- More naturalized hydrograph to promote ecosystem functions that benefit a range of aquatic species.
  - "Freshet"
  - Reduced flow variability during STMP
- Longer freshet, similar magnitude but longer duration STMP flow pulses, and less flow at other times of the year.

Bookend Flow Alternatives – Alt 4

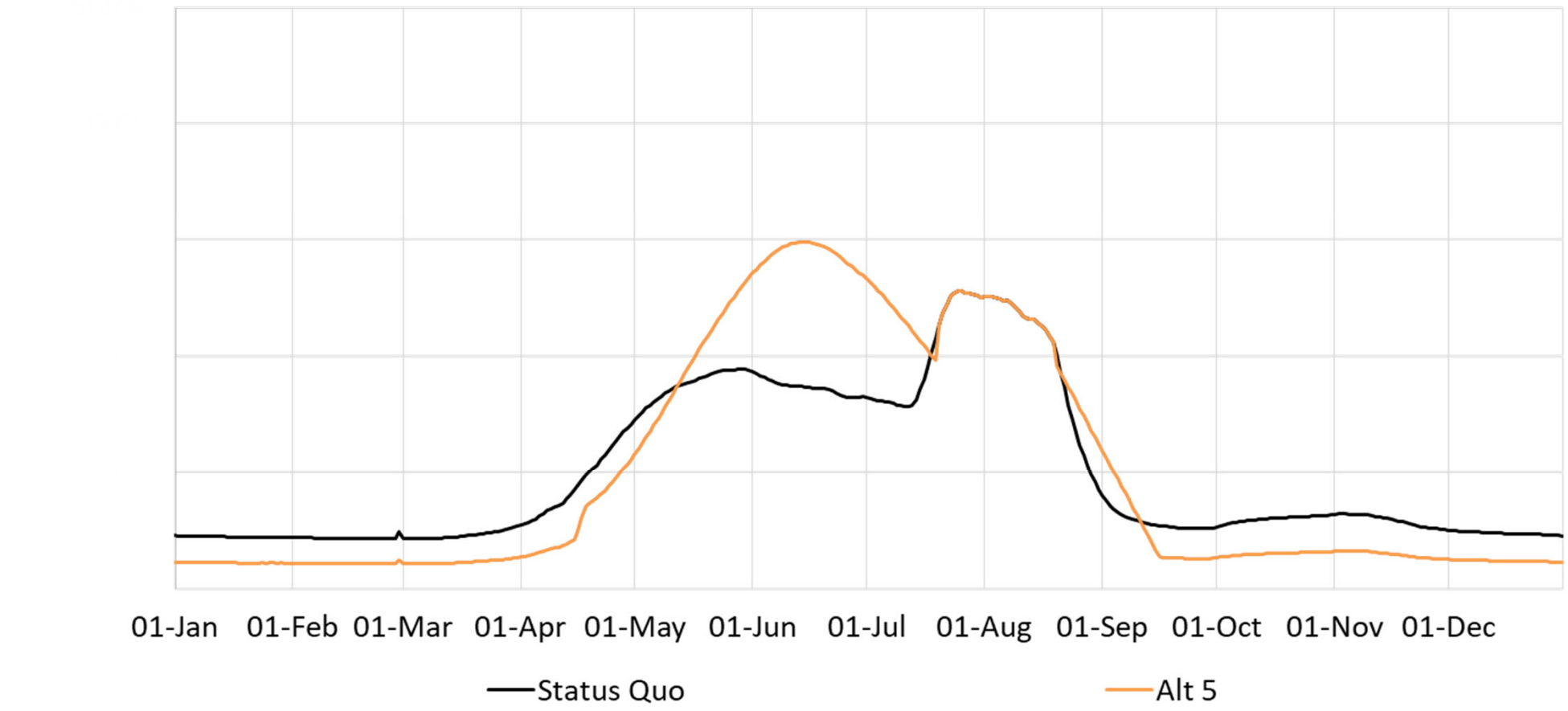


Bookend Flow Alternatives

<u>Alt 5 – Reservoir Wildlife (birds)</u>

- Minimize flooding of bird nests during spring/summer
  - Hold reservoir steady during bird breeding season (prevent nest flooding)
  - Reach full pool prior to bird breeding season (prevent bird nesting)
- Assuming the latter, this will result in higher flow during freshet and lower flow during the fall and winter.

Bookend Flow Alternatives – Alt 5

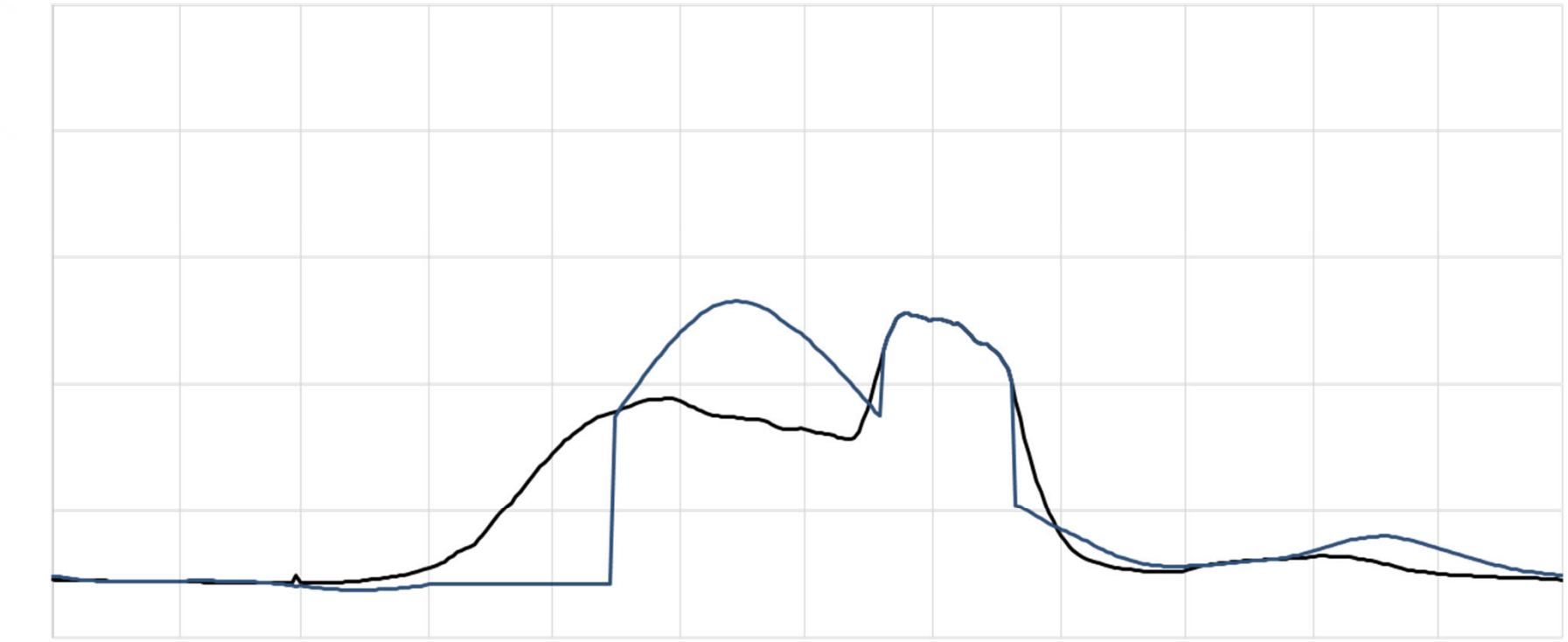


Bookend Flow Alternatives

Alt 6 – Reservoir Aquatic Species & Ecosystems

- Maximize reservoir productivity
- Maximize reservoir elevation during the growing season
- (May – Sept)
- Filling the reservoir quicker (lower river flows during spring/early summer). Once the reservoir is full, flows will likely be higher for end of freshet.

Bookend Flow Alternatives – Alt 6

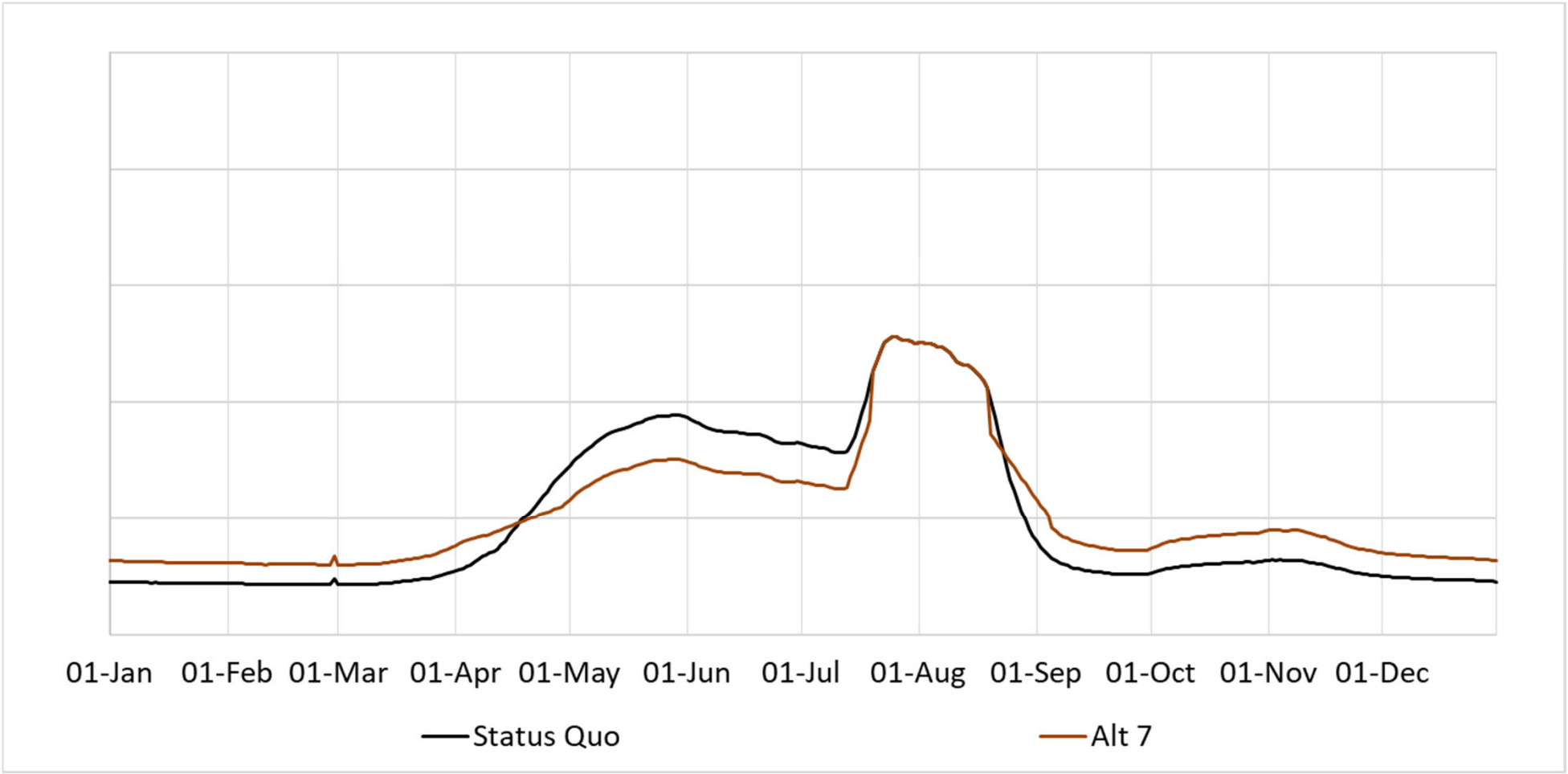


Bookend Flow Alternatives

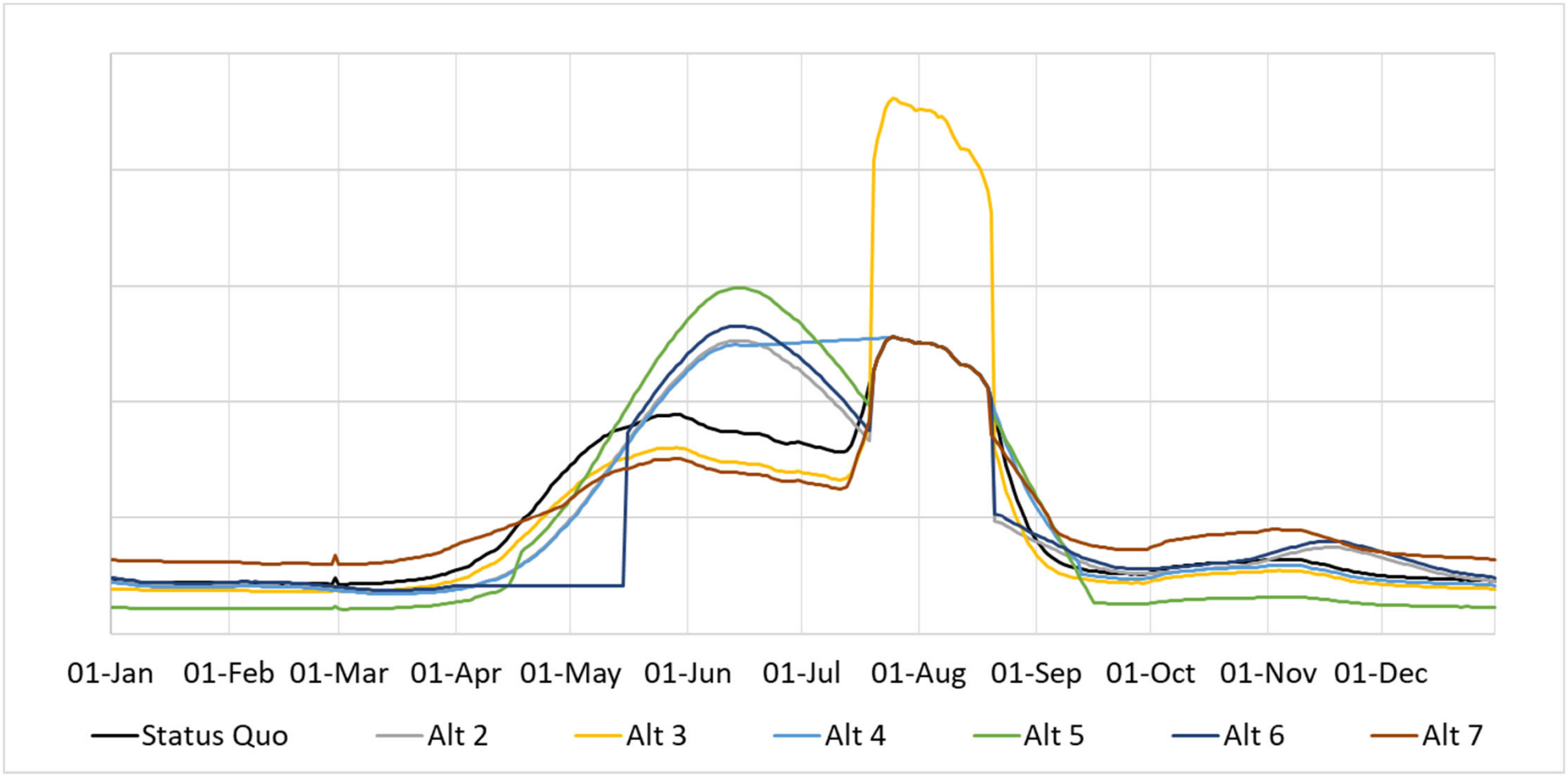
Alt 7 – Flood Mitgation

- Minimize flooding in Murray - Cheslatta and Nechako River
- Hard constraint of 300cms maximum at Cheslatta falls
- Lower reservoir elevations/higher river flow during winter/spring, lower river flow during the freshet

Bookend Flow Alternatives – Alt 7



Bookend Flow Alternatives – all alts



Bookend Flow Alternatives

<u>Alt 8 – Unregulated flows</u>

- To better understand hydrology and the context of the current water control facilities
- Ecofish naturalized flow hydrograph
- No diversion to Kemano, all flows through SLS
- More water in the Nechako River year-round

Bookend Flow Alternatives – Alt 8