



Hydro Effects On Fish and Fish Habitat:

*A Baseline For Improving
Watershed Health*

Nechako WEI meeting

18 March 2020



Outline

- Introduction
- Approach to request for definition of “healthy river”
- Fish species of interest
- Fish life history
- Fish habitat requirements
- Footprint impacts
- Operational effects – reservoir
- Operational effects – river
- Next steps



Introduction

- “healthy river” concept and information request
- Response focused on typical hydro project impacts on fish and fish habitat, in the context of their historical healthy state, and how the present process can achieve some remediation of those effects
- Includes entire Nechako watershed (i.e., river and reservoir) as affected by RT hydro development
- Each of these effects may or may not apply to Nechako system
- Need to apply our collective experience and expertise to refine these
- Towards identification of issues, objectives, impact hypotheses, performance measures, and alternatives



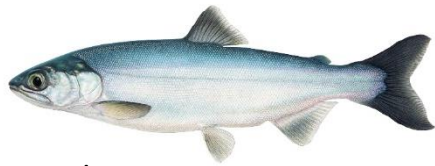
Fish Species Of Interest

- Resident:
 - Reservoir: Kokanee, Inconnu, Burbot,
 - River: White sturgeon, Bull char, Mountain whitefish,
- Anadromous:
 - River: Chinook, Sockeye salmon
- To be discussed and refined as needed
- Representative species with similar life histories and habitat requirements can serve as proxies, and simplify analysis



Fish Species Of Interest

Reservoir



Kokanee



Inconnu



Burbot

Anadromous



Chinook salmon



Sockeye salmon

River

Resident



White sturgeon



Bull char



Mountain whitefish



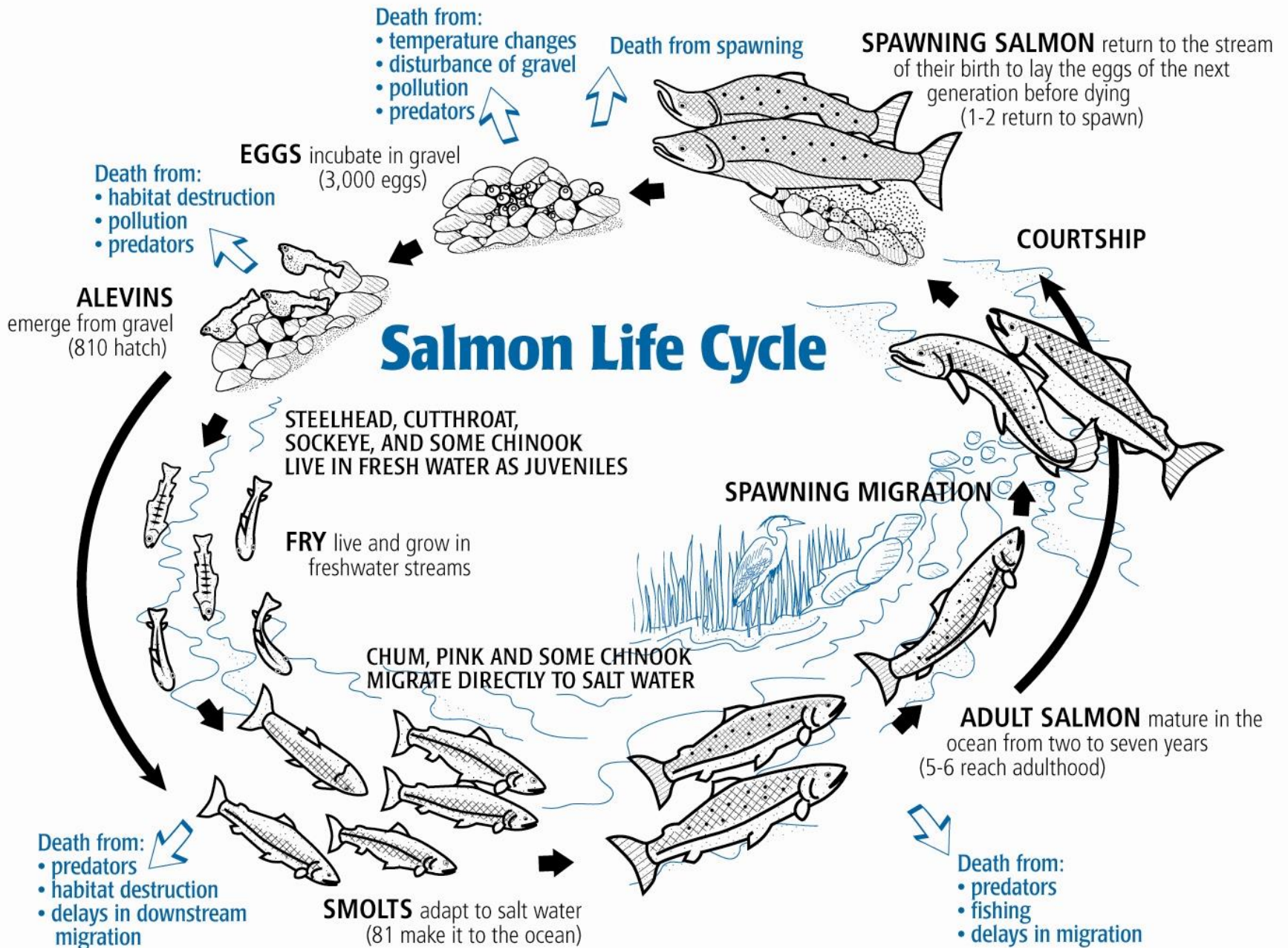
Fish Life History: Resident

- Migration: navigating freshwater environment, between habitats required to complete life history
- Spawning: staging, broadcasting eggs or depositing in redds
- Incubation: egg development, hatching
- Rearing: emergence, drift, hiding, seeking cover
- Feeding: primary, secondary productivity; instream and terrestrial sources; invertebrates, fish
- Overwintering: refuge, depth, ice cover



Fish Life History: Anadromous

- In-migration: adults entering freshwater, navigating (rock slides, waterfalls, shallows) upstream to spawning areas
- Spawning: staging, building redds, depositing eggs
- Incubation: egg development, hatching (alevin)
- Rearing: emergence (fry), freshwater residence (parr), smolts
- Feeding: primary, secondary productivity; invertebrates; instream and terrestrial sources
- Overwintering: as parr; refuge, depth, ice cover
- Outmigration: smolts traveling downstream to sea





Physical Habitat Requirements

- Migration: passage/access, flow/hydraulics, temperature, water chemistry, other cues
- Spawning: flow/hydraulics, substrate, channel form, groundwater, temperature, water chemistry
- Incubation: flow, depth, temperature, oxygenation
- Rearing: refuge, depth, velocity, substrate/interstices, structure, riparian, off-channel, passage/access
- Feeding: water quality, chemistry, nutrients, temperature, productivity, riparian, prey
- Overwintering: refuge, water depth, temperature, structure, channel form, off-channel



Salmonid Redd

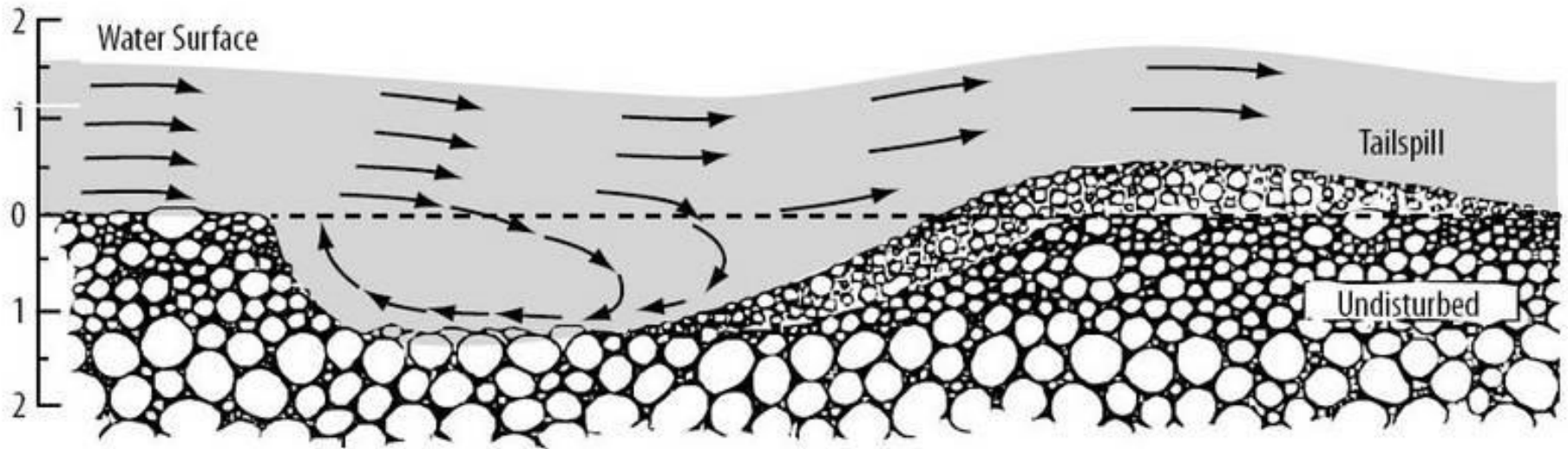
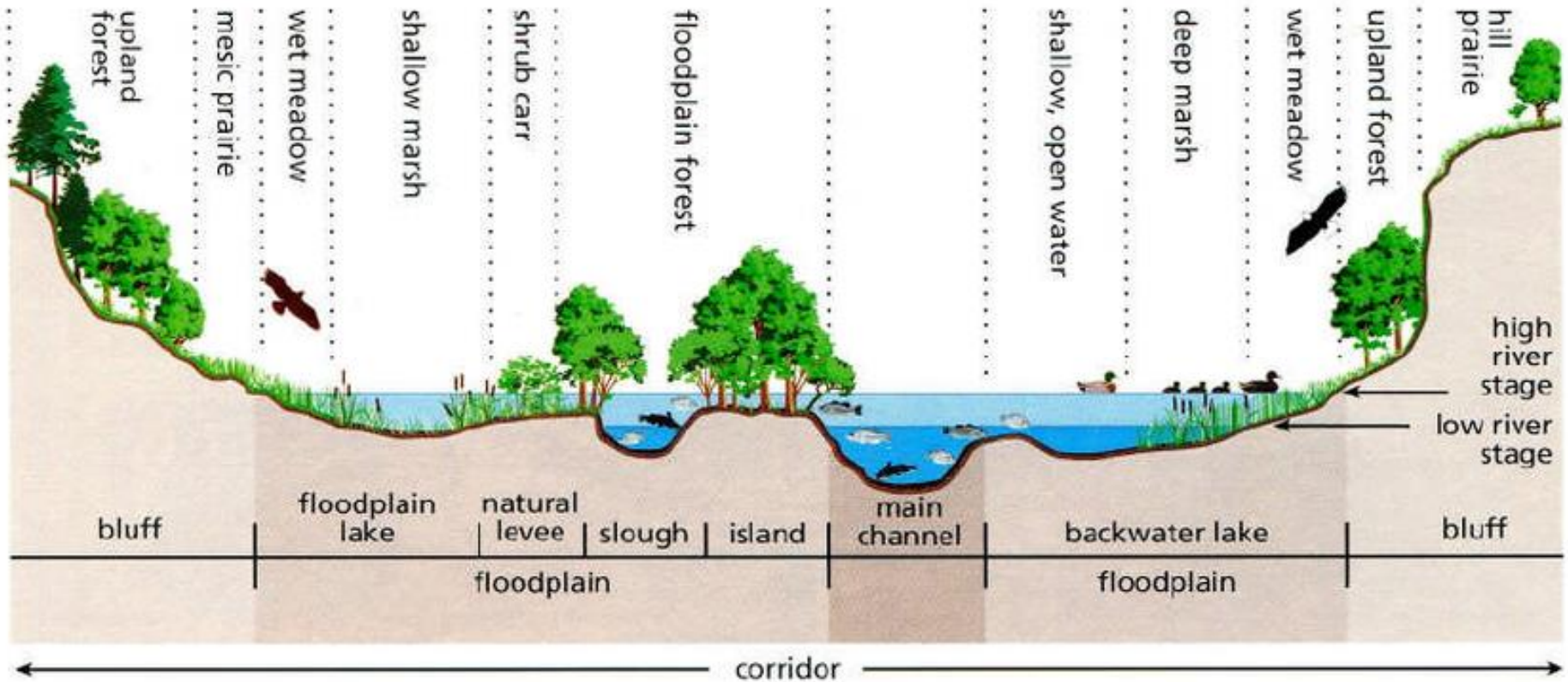


FIGURE 1.— Typical currents in a salmonid redd (Illustration: Andrew Fuller, from Burner 1951, 98)



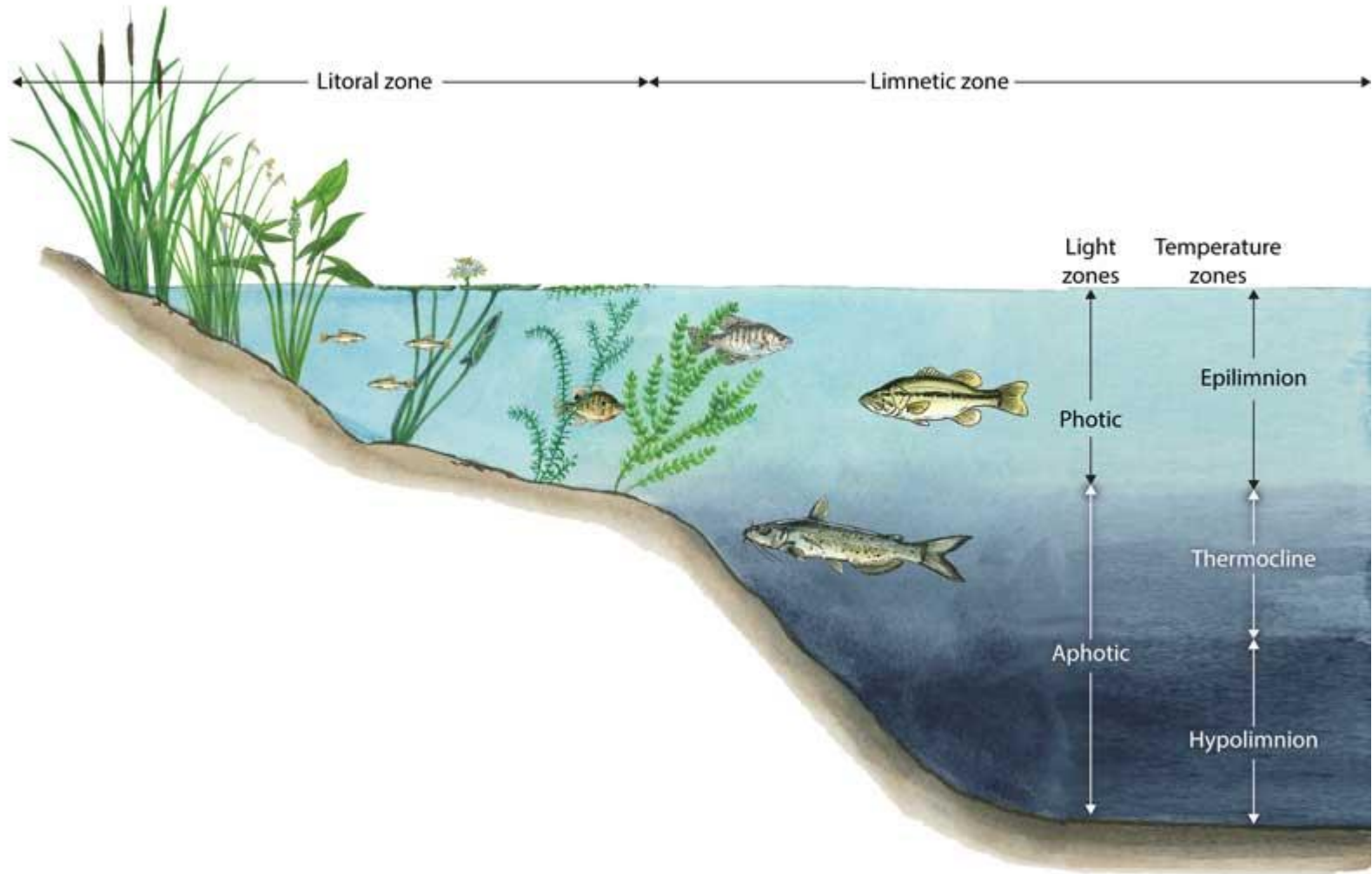
River Cross Section



From Milhous et al. 2012. Modeling environmental flow needs for riparian vegetation. Conference: American Water Resources Association 2012 - Riparian Ecosystems IV: Advancing Science, Economics, and Policy. Denver, Colorado.



Reservoir Zones





Hydro Footprint Impacts

- Related to original establishment of project
- Cannot be mitigated through operations
- Mitigation requires infrastructure changes; can be challenging from technical, business, and cost perspectives
- Can be offset



Footprint Impact Examples

- Physical habitat displacement by dam structures
- Reservoir formation: ecosystem conversion, dead storage, thermal profile
- Sediment retention: changes in channel morphology, turbidity, substrate size and distribution
- Passage barrier: dam impedes upstream and/or downstream migration of fish
- Entrainment: Fish injury/mortality, displacement
- Infrastructure constraints: water delivery mechanisms



Hydro Operational Effects

- Related to ongoing water management, and maintenance of existing facilities
- Mitigation through operational changes, facilitated by infrastructure changes as required and cost-effective
- Can be more feasible and cost-effective to address than footprint impacts
- Can be offset



Reservoir Operational Effects

- Water levels: habitat suitability and availability, tributary access, redd inundation
- Downramping: fish stranding, habitat dewatering
- Downstream passage: fish outmigration, entrainment
- Upstream passage: fish in-migration
- Water quality, chemistry, temperature
- Riparian function: shade, food supply, woody debris recruitment
- Productivity: primary, secondary, invertebrates, fish, wildlife



Downstream Operational Effects

- Instream flows: hydrograph shape (discharge, timing), base flows, peak flows
- Upramping: fish displacement
- Downramping: fish stranding, habitat dewatering
- Upstream passage: fish in-migration
- Downstream passage: fish outmigration, entrainment
- Habitat access: tributaries, sidechannels, off-channel



Downstream Operational Effects, cont.

- Channel morphology: simplification, incising, substrate armoring, floodplain function
- Thermograph: release temperatures
- Total dissolved gas: gas bubble trauma
- Water quality, chemistry
- Riparian function: shade, food supply, woody debris recruitment
- Productivity: primary, secondary, invertebrates, fish, wildlife



Next Steps

- Develop and document broad objectives for each interest
- Refine potential impacts and issues to those that apply and affect objectives for Nechako
- Convert into impact hypotheses
- Identify essential data gaps to confirm hypotheses and understand mechanisms
- Data gaps addressed by MT and/or TWGs through existing information , expert advice, and new studies, as required



Next Steps, cont.

- Develop performance measures that quantify (or qualify) relationships between facility operations and objectives
- Develop operational alternatives
- Identify potential non-operational measures, as appropriate and cost-effective
- Evaluate, refine, and iterate alternatives based on PM outcomes
- Achieve consensus on an alternative that best balances tradeoffs between objectives, and recommend to RT for implementation



Thank You

Questions?