To:	**WEI Technical Working Group members**
From:	Jayson Kurtz, TWG Coordinator, Ecofish
Date:	April 28, 2021
Re:	**Summary of TWG meeting held Wednesday, April 28, 2021, 9:00 am to 12:00 am**

Attendees:

- Dan Sneep (DFO)
- Andy Lecuyer (RT)
- Alec Mercier (RT)
- Duncan McColl (FLNRORD)
- Rahul Ray (EDI)
- Jayson Kurtz (Ecofish Research Ltd.)
- Jennifer Carter (Ecofish Research Ltd.)
- Katie Healey (Ecofish Research Ltd.)
- Nikolaus Gantner (FLNRORD)
- Phillip Krauskopf (FLNRORD)

Meeting Objective: discuss PMs for the next MT meeting and brainstorm remaining interests regarding reservoir fish and river fish, and revisit wildlife interests.

Agenda:

- MT debrief and review MT comments on objectives.
- Katie to present on PM ideas and discussion on PMs for the next MT meeting.
- Summary of information assessments: chronic temperature effects on migrating salmon (considering thermal history).

MT Meeting Debrief

- Uncertainty around objectives: SMART vs directional
- Important for us to support MT.
- Next meeting will focus on process.
    - We will be providing a few PMs for MT to work through the process next meeting.

Discussion on Models

- Discussion on RT models and how they can be applied:
    - Optimization model:
        - Proprietary model, only RT can run, but still important that we generally understand.
        - 2 modes: forecast and historical
        - Based on historical hydrological record (back to 1950s) but hydrology is changing that may not be existent in historical record. A few options to adjust for this is to:
            - Incorporate how flows may change regarding climate change scenarios (climate scenarios have been ongoing with UNBC and others that can be incorporated).
            - Truncate historic record for most recent years.
    - HEC-RAS flood model:
        - Based on channel shape – relies on channel cross-section/profile surveys
        - Models water shape (depth and width) compared to discharge.
        - Uses output from optimization model and can be used to evaluate instream scenarios.
        - Currently models to Prince George but the best data available is near Vanderhoof and upstream.
        - We should consider what field work is needed to validate model, or to make it more useful for our needs.
    - Temperature model
        - Specifically for STMP and run by Triton.
        - Uses river temperature and weather forecast to determine volume of SLS releases to not exceed 20°C at Finmore.

<u>Discussion on Modelling</u>

- An informative group discussion on modelling, targets, and hard constraints. There was general agreement that the level of detail discussed was appropriate for the TWG but we will need to think about how to effectively articulate model discussions with the MT.
- A few key points to consider when using these models:
    - Need to understand how hard and soft constraints work. Hard constraints limit learning, flexibility, opportunities to address other interests.
    - Need to understand whether temperature is constraint or PM.
        - Would like temperature to be PM so we can have various scenarios to look how all interests will be evaluated, and then we can make decisions on what is acceptable.
    - Need to understand model limiting factors and certainty (i.e., what was the model developed for and how might that influence how we use it?)
    - Need to understand and always consider strength and weaknesses of model (i.e., what can or can't it do, how can we understand the results?)
    - Need to understand how model outputs relate to real aquatic thresholds/bottlenecks – limited data.
    - Need to understand precision and accuracy – precision not always needed, most PMs are about relative change, comparison.

  - How do we validate model, ensure it represents the ecological interests?
  - How do we monitor results of flow?
  - How do we evaluate natural hydrograph (Natural flow paradigm)?
  - How do we develop PM's with limited data?

Presentation on instream flow PMs

- Multiple approaches are available to evaluate instream habitat that consider amount and suitability.
- Habitat suitability index (HSI) is a relationship between how well habitat functions at different flows.
  - Can be stream-specific or not.
  - Flow (discharge) is often expressed as mean annual discharge (MAD).
- Can also have relationship curves for macroinvertebrates to explore fish food availability.
  - Most WUP processes don't show sensitivity to lower trophic levels and have not included HSI curves.
- Instream flow PM for river fish:
  - The "gold standard" is an HSI curve for each species and life history stage, and would be applied during the critical time period of interest.
    - based on habitat-flow relationships specific to the stream.
  - Simple generic flow threshold
    - Is binary, only sensitive at a specific flow.
    - 20% MAD is a general BC "standard" for suitable fish habitat.
    - Doesn't need much information but also doesn't consider much information.
  - Meta-analysis method
    - Summary of HSI curves derived for other streams.
    - Choose a proxy stream with similar characteristics as Nechako.
      - Often challenging with larger systems.
      - Could use HEC-RAS model output and compare to proxy stream to provide validation.
  - Professional judgement
    - Could use expert judgement to develop relationship.
    - Takes simple generic flow threshold and makes assumptions of shape of relationship based on stream properties.
    - WUP Delphi approach by Ptolemy is an example.
    - Need agreement and sound understanding on shape of relationship.
- How to evaluate a natural hydrograph:
  - Indicators and metrics for environmental flows method
    - Can calculate deviation from natural flow regime to evaluate how well each indicator measures against the natural system.

Information Summaries:

Ecofish presented an information summary of one action item assigned during the TWG meetings:

- Effects of chronic temperature exposure on salmon

The summary is provided below and will be forwarded under separate cover when complete.

TWG Discussion

Effects of chronic temperature exposure on salmon, comments and considerations:

- Can consider accumulated degree days (500-600 threshold) or consecutive days above 18/19°C (1 week)
- UNBC paper recreated temperature profiles as if no diversion (~1°C higher now than 1950's, Stuart 1.3°C)
- UNBC paper on Fraser basin chinook stream temperatures:
    - Stuart was warmest stream, many days above 20°C.
    - Nechako was also warm.
    - Other watersheds cooler, few days above 20°C (higher elevation than Stuart and Nechako).
- Can we create temperature plots by year for Nechako assuming a) no-diversion b) diversion c) diversion + STMP and summarize number of days above 20°C?

Action Item – follow up with Stephen to see how academic temperature modeling can be used to develop/inform PMs.

Next TWG Meeting

- Need to be thinking about how we want to establish PMs for resident fish issues, which we will be discussing at the next meeting.

Information Summaries

Chronic effects of WT on migrating salmon (i.e., thermal history)

Understanding how chronic exposure to high temperatures effects salmon migration survival is an important piece to consider when determining temperature management targets.

- Exposure to high water temperatures in the Fraser River affects the condition of salmon once they reach the Nechako River.
    - Harsh migration conditions can elevate routine metabolic costs, thus, reducing aerobic scope available at the end of their migration. Therefore, a temperature target associated with aerobic scope should consider previous migration conditions.
- Chronic exposure to high temperatures during migration can exacerbate parasite and disease development and induce stress responses that lead to reduced migration survival, especially near the end of migration.
- Chronic exposure to warm temperature is known to accelerate the development of pathogens and disease in salmon.

    - Accumulated degree-days greater than 500°C to 600°C can result in severe development of the kidney parasite *Parvicapsula minibicornis.*
        - Severe microbial infection can lead to osmoregulatory impairment and chronic stress, which can cause mortality.
    - Early Stuart sockeye salmon that died pre-spawning were found to have higher rates of microbial infection than those that survived.
        - The type of microbes that were most prevalent in these fish were associated with stress and injury, and diminished immune responses.
- Chronic exposure to warm water can lead to thermal stress responses (detected by immune or stress gene expression), which can cause physiological impairment and mortality.
    - Stressor-induced mortality can be delayed by more than a week, which is why mortality from chronic temperature exposure is more prevalent at the end of the migration.
    - Sockeye and pink salmon, and in particular females, exposed to 18-19°C for a week showed signs of thermal stress and had higher mortality than those exposed to ≤14°C.
        - In particular, for summer-run (Chilko/Horsefly stocks) female sockeye salmon mortality spiked after 6 days of experiencing 19°C, and by 10 days more than 60% of overall fish died.
        - Increases in immune gene expression were observed in pink and sockeye salmon that were maintained after 5–7 d of chronic thermal stress.
    - Telemetry studies show similar results.
        - Migration survival in Late Shuswap sockeye salmon was consistently high when river temperatures were 14°C and were lower when river temperatures were 19°C, and at 19°C mortality continually increased throughout the migration.