COLUMBIA RIVER REGIONAL FORUM TECHNICAL MANAGEMENT TEAM
2019 Year End Review
December 11, 2019

DRAFT FACILITATOR'S SUMMARY
Facilitator: Emily Stranz; Notes: Colby Mills, DS Consulting

The following Facilitator's Summary is intended to capture basic discussion, decisions, and actions, as well as point out future actions or issues that may need further discussion at upcoming meetings. These notes are not intended to be the "record" of the meeting, only a reminder for TMT members. Official minutes can be found on the TMT website: http://www.nwdwc.usace.army.mil/tmt/agendas/2019/.

Welcome and Introductions

DS Consulting facilitator, Emily Stranz, welcomed the group to the Columbia River Technical Management Team's (TMT) 21st annual Year End Review (YER). She explained that the review is an opportunity for TMT members and other interested parties to look back on the past year's in-season management operations and reflect within a collaborative mindset on takeaways, lessons learned, and ideas for future management.

Emily noted that the format for this year's meeting allows time for group conversations on key 2019 operations and encouraged participants to consider the following questions during discussions:

1. From your perspective, what is the biological significance of these operations/outcomes?
2. What did we learn about specific operations requested by TMT members or other regional entities?
3. How effective were these operations in achieving the intended goal?
4. What changes in outcomes are expected with 2020 spill to 125% and potential for different hydrological conditions?
5. What questions still need to be answered?
6. What have we learned this year that will inform future problem solving and decision-making?

Federal Columbia River Power System Biological Opinion

Paul Wagner, NOAA, reviewed the TMT's purpose as it relates to the 2019 CRS Biological Opinion (BiOp) and summarized the changes in the 2019 BiOp relative to the 2008 BiOp. The 2019 BiOp is expected to be in place through 2020. Paul's presentation can be viewed here.

Paul discussed:

- An overview of the 2019 BiOp's Proposed Action.
- Specific hydro-operation actions for the flexible spill program, including spilling water for 8 hours a day to project specific performance levels, and increasing spill up to 120% TDG limits in 2019 (up to 125% in 2020) for the remaining 16 hours each day.
- The tributary habitat framework and Research Monitoring and Evaluation plan (RM&E).
- NOAA's Life Cycle modeling, conservation recommendations, and an explanation of the Incidental Take Statement (ITS), which includes RM&E efforts.

Paul highlighted key conclusions from the 2019 CRS BiOp, noting that NOAA found the Proposed Action is not likely to jeopardize salmon, steelhead, and eulachon, or harm respective the critical habitat. Critical habitat and the ESA-listed populations of green sturgeon and Southern Resident killer whales are not likely to be adversely affected. NOAA made a no jeopardy call on Snake River spring/summer-run Chinook salmon, sockeye, and steelhead based on analysis of species status, the environmental baseline, the effects of the action, and the interim nature of the action pending development of a new action stemming from the Columbia River System Operations National Environmental Policy Act (CRSO NEPA) process.

In regards to the flex spill operations included in the 2019 BiOp proposed action, Jay Hesse, Nez Perce, cautioned expectations around the flex spill operation providing the opportunity to test latent mortality, noting that a statistical evaluation would take consistent operations across multiple years (at least 7). The flex spill operations were a short-term agreement and are not expected to provide definitive information on whether the operation changed juvenile travel times, survival, or smolt to adult return rates.

"Take-Aways" Regarding the 2019 BiOp:

- There was a desire for additional conversation and clarification on the ITS and whether take for RM&E is be "double counted" due to the 2019 BiOp take coverage for RM&E in tributaries and separate consultation for RM&E.

Total Dissolved Gas and Flexible Spill Operations

Dan Turner, USACE, recapped the 2019 spill season conditions, 2019 flexible spill operations, and total dissolved gas (TDG) targets and levels. He also looked ahead to 2020 flexible spill operations and 125% TDG gas caps, and gas bubble trauma monitoring. Dan's presentation can be viewed here.

Dan discussed:

- Details of the 2019 flexible spill operations for juvenile fish passage and plans for the 2020 spring spill season.
- The Corps' internal procedure and process to set spill caps for gas cap spill, as well as 2019 adaptive spill management for each project.
- The increasing trend in average spring spill for the Snake and Columbia Rivers from 2015-2019 (this includes forced/involuntary spill).

Dan noted that the 2020 flexible spill operation sought to learn from the 2019 operation and takes into account the relationship between John Day and The Dalles tailwater and forebay TDG levels. In 2020, TDG levels will be up to 125%, which Dan noted could result in hitting spill reduction triggers for Gas Bubble Trauma (GBT) more frequently than in the past.

In order to spill at 125% TDG, Oregon and Washington states are revising their water quality standards. Dan noted some uncertainty in what the revisions will look like, but suggested that there may be resident aquatic life monitoring for GBT.

"Take-Aways" Regarding TDG & Flex Spill in 2019

- TMT worked collaboratively in 2019 to adaptively manage the spill operation.
- More information on the anticipated flow volumes required to meet spill caps and minimum generation would be appreciated in 2020; is there a way to get estimates of how much flow is needed to meet the minimum generation and gas cap levels?
    - NOTE: One suggestion was taking the minimum generation at each project and adding it to the estimated spill cap volume (the Fish Operations Plan has minimum generation tables).
- TMT members would like to have process conversations around aspects of in-season coordination for 2020, specifically around any process changes or additions (i.e. elevation of issues in season to the RIOG or the Flex Spill Group, how to respond if GBT triggers are met).
- Conduct a deep dive into the John Day and The Dalles operations and compare and contrast operation data with smolt survival data.

Spring Chinook Passage

Dave Swank, USFWS, reported on adult spring Chinook passage timing and conversion between Lower Monumental and Lower Goose Dams for 2019 and 2018. Dave's presentation can be viewed here.

Dave discussed:

- The metrics used for tracking and counting fish passage, including perspective on the benefits and caveats for each metric.
- A summary of the Lower Monumental to Little Goose adult arrival timing and end-of-season conversion and travel time impacts to adults, as well as impacts on juveniles (as noted in the Fish Passage Center memos 24-19 and 30-18).
- Harvest counts in the Snake River and specifically downstream of Little Goose; a look at harvest rates in 2018 and 2019 and whether the exceeded management quotas.
- Management implications from USFWS' perspective: utilize years of passage data to tailor management response, and consider that not all delays in passage have the same impact and should be considered on an individual basis.
- More information is needed on conversion and spawning upstream of Lower Granite, as well as the increase in the number of "slow" converters.

Erick Van Dyke, ODFW, took a system-wide look at spring Chinook passage, recapping the Chinook salmon life history, including juvenile and adult migratory periods. Erick's presentation can be viewed here.

Erick discussed:

- Travel time from first PIT tag detections of spring migrating Snake River Chinook at Bonneville through the system and found that trends were similar over the last six years of available data even though different spill operations were implemented. All six years showed adults slowing their rate of travel as they entered the Snake River regardless of the spill operation that was implemented. These trends also showed that impressions of delay (slower traveling adults) were largely driven by the skew in distribution of upper percentile range (slower travel rates) rather than the standard fish experience (median travel rates).
- Available research addressing adult Chinook salmon passage concerns identified immediately following completion of Little Goose and Lower Granite Dams, with emphasis on operational changes at Little Goose Dam.
- A summary of the Fish Passage Center's memo (FPC memo June 22, 2018 47-18) that encouraged managers to recognize and identify risk among each life stage when considering adaptive management changes in dam operations meant to benefit one life stage. Important consideration included 1) relationships associated with being transported as a juvenile, 2) how each juvenile powerhouse encounter reduce subsequent SAR 9–13%, and 3) association of seven other factors shown to negatively influence upstream migration rates. The FPC evaluation found little evidence that adult upstream survival could be appreciably affected by the time spent in the impounded lower Snake River.
- How lessons learned since 2018 were used to tailor project level operations, like adult passage concerns at Little Goose, to help fine tune the Flexible Spill Operations Agreement while retaining the original logic path established to decrease powerhouse encounter probabilities by increasing spill to improve SAR to meet 2-6% goals.

There was inquiry as to whether Little Goose operations would increase PITPH at other projects, to which Erick explained that the Flex Spill Agreement considered systemwide impacts of PIT PH. Erin Cooper, Fish Passage Center, added that spill reduction to 30% and ponding at Little Goose increases PIT PH at downstream projects, as overall flow is being reduced and thus impacts spill levels downstream.

Charles Morrill, WDFW, reported on adult ladder count data for spring and summer Chinook salmon, including some ideas on how to account for fallback and re-ascension. Charles' presentation can be viewed here.

Charles discussed:

- A recap of the data on travel times for hatchery and wild origin PIT tagged adults, and for juveniles tagged above or at Lower Granite.
- Individual site return travel times, noting that harmonic travel time is fairly short, but there are "outliers" which can influence how we approach management of spill operations at Little Goose.
    - NOTE: Some voiced concern with considering those with faster or slower travel time as "outliers" noting that these fish have evolved to migrate in specific ways in response to environmental variability.
- Ladder counts continue to be a tool for assessing in-season passage; however, it is necessary to consider the limitations in these data.
- There is not a clear or reliable approach currently available to estimate daily fallback and re-ascension, as there is too much variability. However, weekly count totals can be adjusted based on PIT tagged adult passage and PIT estimated fallback/re-ascension data to correct total passage counts and estimate in-season conversion rates.

Claire McGrath, NOAA, reviewed Snake River spring and summer Chinook adult passage in the Lower Snake River. Claire's presentation can be viewed here.

Claire discussed:

- NOAA and the NW Science Center's COMPASS model runs which looked at downstream survival, travel time, and percent transported for of juvenile Chinook salmon and steelhead in the Snake River under variable river conditions and with various management actions at Little Goose Dam. Specifically, they considered juvenile travel time with both 120% and 125% spill regimes.
- An updated summary of Lower Snake River spring Chinook salmon passage, including metrics used for tracking in-season passage (DART and FPC tools).
- A summary of a recent study (Siegel and Crozier, 2019) that looked at how upstream travel time and river conditions in the Lower Snake and Lower Columbia Rivers relate to survival upstream of Lower Granite Dam.

"Take-Aways" Regarding Spring & Summer Chinook Passage

- Once a fish is observed moving slow, it appears to continue migrating slowly (according to NWSC model).
- What management options support fish that are slow to move upstream, while not harming out migrating juveniles?
- The DART and FPC passage timing tools have proven to be helpful support for TMT conversations and decision making. Continuing to improve these tools (for example expanding to include more than 3 days) could be valuable for in-season management.
- Consider whether there are additional metrics that would be helpful for in-season management of during adult passage and juvenile migration.
- Lower flows and higher water temperatures (as seen in 2018) cause significant delay, are there management tools to better support migrating fish in these conditions?
- Conversion rates to spawning grounds do not capture other important outcomes, for instance, providing harvest opportunities for the tribes. Fish that move slower through the system are not as high quality and it is important that the fish can get upstream in the natural timeframe.
- Are there ways to retrospectively test the COMPASS results with actual data to see how accurate the model was and then to track whether the runs are within the range expected?

Smolt Survival and Travel Time & Transportation Analyses

Steve Smith, NOAA, reviewed data on migration conditions, travel time and survival of PIT-tagged smolts through the hydropower system in 2019, and data on smolt-to-adult returns for fish that were either transported from or bypassed at dams during migration years 2015-2017. Click here to view Steve's presentation.

Steve discussed:

- The 2019 spring conditions entailed above average flow, above average spill, near average water temperatures, longer travel times than in other recent high-flow years, and earlier than average smolt migration.
- The 2019 spring survival estimates for Chinook, steelhead and sockeye.
- Daily percentage spilled and daily dissolved gas saturation at Snake River projects
- Passage timing and travel time throughout the system.
- The estimated transported percentage of yearling Chinook, steelhead and sockeye.
- Estimated SARs for transported and bypassed fish from migration years 2015-2017.

Steve shared that he expects to complete a "data report" with multiple years of transportation information something in the first half of a 2020, and a report of analysis synthesizing multi-year data in the second half of 2020.

<u>"Take-Aways" Regarding Smolt Survival & Transport</u>

- 2019 is characterized as a "high spill" year; however, 2017 and 2018 had higher percentage of spill, but with different management intentions and environmental conditions (flow).
- Should the transportation start date in 2020 be moved to July?
- Consider earlier smolt migration and potential need for changes for monitoring, operations, etc.
    - Develop a long term plan and rationale for need for change (FPOM conversation).
- Pinpoint where the differences in travel time originate; are there particular reaches where smolts might be particularly delayed?
- Is there something about flow or spill conditions that is causing a loss in benefit of travel time relative to flow?
- Use real-time video to monitor and reflect on conditions and changing physical flows at each project.
- Keep an eye on tailrace hydraulics; tailrace hydraulics are important variables in survival and higher travel times.
- Is there a way to analyze transport and survival data to inform management decisions?

Lessons Learned and Future Conversations

In a large group, participants reflected on the conditions, decisions and actions from 2019 and discussed the overarching lessons that could impact future work efforts at TMT. They brainstormed topics and themes that need further discussion at TMT in 2020.

- Reflect back on 2018 and 2019 flow and spill volumes to see if there is information that might help inform 2020 operations.
- Review tailrace conditions and potential impacts on juvenile and adult travel and survival.
- Continue the deep dive into conversion rates to spawning grounds.
- From a management perspective how can TMT support the entire run as they migrate, including those travelling faster or slower than the majority.
- Prior to the spring spill season, clarify the process for responding to gas bubble trauma sequence triggers; are there changes due to state water quality standard changes?
    - Are there potential tools that can be developed to support this process?
- Clarify the dispute resolution process and relationship between the Flex Spill Team, TMT and RIOG.
- Clarify whether the summer transport starting date will be determined via Flex Spill Teams.
- Look into Section 7 coverage under the 2019 BiOp and whether there is redundancy with take from RM&E.
- Consider utilizing a flow trigger for starting juvenile transport.

- How to use smolt survival estimates as a tool for in-season management.

Additionally, participants were asked to reflect as a group on TMT conversations, coordination, operations and outcomes over the last year and to consider: What lessons would be helpful to carry forward into future years; what did TMT do well; and, what would the group like to do differently in the coming year. The following thoughts were expressed by group members:

What Worked Well in 2019?

- The Corps and Fish Passage Center provided timely summaries of TDG data, which supported daily decision-making during spring spill season.
- TMT utilized the tools developed by FPC and DART to make in-season decisions.
- Individual TMT members efforts, for example Claire's summary of passage effects at Little Goose Dam in-season, Jay clearly articulating concerns and presenting solutions, Doug organizing TMT meetings well.
- Facilitation helped keep conversations focused.
- Working relationships between TMT members were cooperative and collaborative, for example when coordinating the chum operation.
- There were shared learning opportunities.
- Process meetings were used as an opportunity to come together and helped facilitate discussion.

Changes for 2020 Operations

- Organize a TMT field trip to visit one of the sites discussed at TMT.
- Broaden conversations to consider long-term solutions, rather than only in-season management.
- Capture operations that have alignment in writing and memorialize the operation so that the TMT can build off of the work instead of having to re-hash over again in-season and in coming seasons.
- Consider shifting the face-to-face meetings to start at10:00 AM to allow for travel time.
- Choose either C° or F° for temperature unit.

Emily thanked the presenters and meeting participants for their engagement and meaningful conversation throughout the day. And with that, the meeting was adjourned. All presentations and handouts can be found on the TMT website.

Present for all or part of the meeting:
Jeff Allen (NWPCC), Leslie Bach (NWPCC), Doug Baus (USACE), Heather Baxter (USACE), Tim Belden (Energy GPS LLC), Scott Bettin (BPA), Trevor Conder (NOAA), Erin Cooper (FPC), Peter Cooper (BOR), Jonathan Ebel (IDFG), Joel Fenolio (BOR), Steven Hall (USACE), Melissa Haskin (FLUX Resources), Laura Hamilton (USACE), Lance Hebdon (IDFG), Jay Hesse (Nez Perce Tribe), Tom Iverson (Yakama Nation Fisheries), Tucker Jones (ODFW), Jim Litchfield (MT), Aaron Marshall (USACE), Claire McGrath (NOAA), Alexis Mills (USACE), Charles Morrill (WA), Tony Norris (BPA), Michael O'Bryant (CBB), Joshua Rasmussen (Energy GPS), Jon Roberts (USACE), Gabe Scheer (FPC), Sheri Sears (Colville Tribe), Ann Setter (USACE), Kevin Shaffer (USACE), Steve Smith (NOAA), Leah Sullivan (BPA), Dave Swank (USFWS), Josie Thompson (NOAA), Dan Turner (USACE), Todd Ungerecht (NWPCC), Erick Van Dyke (OR), Paul Wagner (NOAA);

Colby Mills, Nancy Pionk, Emily Stranz, and Donna Silverberg, DS Consulting Facilitation Team.

Columbia River Regional Forum
TECHNICAL MANAGEMENT TEAM
2019 Annual Review of Lessons Learned
December 11, 2019

Minutes: Melissa Haskin, BPA (contractor, FLUX Resources)

1. INTRODUCTION

The goal of the TMT year-end review (YER) is to reflect on operational decisions made throughout the year, and to provide a forum to review decisions, reflect on lessons learned, and discuss ongoing challenges. This year's presentations and discussions focused on TDG/flex spill, Spring Chinook passage, and smolt survival.

These notes are meant to capture the overall presentations and discussions at the TMT YER but are not to be understood as a verbatim transcript. All presentations are available on the TMT website.

2. FEDERAL COLUMBIA RIVER POWER SYSTEM BIOLOGICAL OPINION

Overview: 2019 Columbia River System Biological Opinion – Paul Wagner, NOAA

Paul Wagner, NOAA, took TMT through an overview of the 2019 CRS Biological Opinion (BiOp), which considers the effects of the CRS and related mitigation programs on 13 species of salmon and steelhead along with other Endangered Species Act (ESA)-listed species under NOAA Fisheries' jurisdiction.

This season, the "proposed action" or Flexible Spill operation called for:

- Spilling water at main stem dams 8 hours per day during high power demand and,
- Increasing spill to a maximum of 120% TDG for the remainder of the hours each day

This year's operation allowed for 4 hours in the morning of spill and four hours in the evening, to allow the action agencies to utilize the market to the best of their abilities.

The Flexible Spill operation was supported by Oregon, Washington, The Nez Perce Tribe, and the federal Action Agencies.

Over the years, spill has steadily increased. Increased spill typically reduces juvenile salmon and steelhead passage through the dams via turbine units/bypass systems. The operation begins to look at the latent mortality "powerhouse passage" hypothesis and provides information on juvenile travel times, survival and smolt-to-adult returns. Jay Hesse, Nez Perce, noted, however that as the operation is not a static, long-term operation, the word "evaluation" should not be used. A formal evaluation would require a more static, long-term operation. It would be hard to say that this specific operation, for example, changed juvenile travel times, survival and smolt-to-adult returns.

Overall, the question is, ***"What tributary habitat actions carry the most bang for their buck?"***

Life Cycle Monitoring provides some basis for comparison. Looking at the baseline versus the proposed action, NOAA concluded two things:

1. For salmon, steelhead, and eulachon: The Proposed Action is NOT likely to jeopardize the species or destroy or adversely modify their critical habitat.

2. For green sturgeon and Southern Resident Killer Whales: The Action is NOT likely to adversely affect the species or their critical habitat

NOAA issued a "no jeopardy" conclusion based on analysis, pending any new actions that would be due to a new BiOp. Originally, it was thought the BiOp would be THROUGH 2020 but the president issued a directive pushing the timeline up to the beginning of 2020. The EIS is scheduled to be out in fall of 2020 and the BiOp should be released in June to hit the September NEPA deadline.

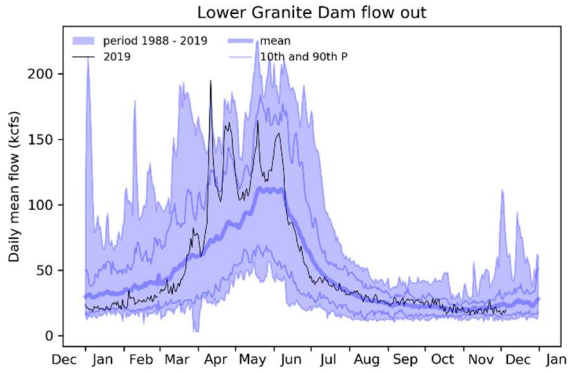
Wagner reported additional details on the Reorganized Reasonable and Prudent Measures (RM & E) as noted in the Incidental Take Statement. Jay Hesse, Nez Perce, asked for additional clarification and conversation on if the RM & E doubles coverage with section 7.

3. TOTAL DISSOLVED GAS AND FLEXIBLE SPILL OPERATIONS – DAN TURNER, CORPS – NWD

Dan Turner, Corps, gave an update on 2019 operations, which ran April 3 – June 20 at Lower Snake River projects and April 10 – June 15 at Lower Columbia River projects. Summer spill ran through August 31.

Turner covered 2019 spill season conditions, provided a summary of TDG targets and levels, talked about lessons learned from this spill season, and provided a look-ahead into 2020 operations.

The April-August runoff at Lower Granite totaled 24.6 Maf, or 116% of average and The Dalles totaled 81.0 Maf, or 93% of average.



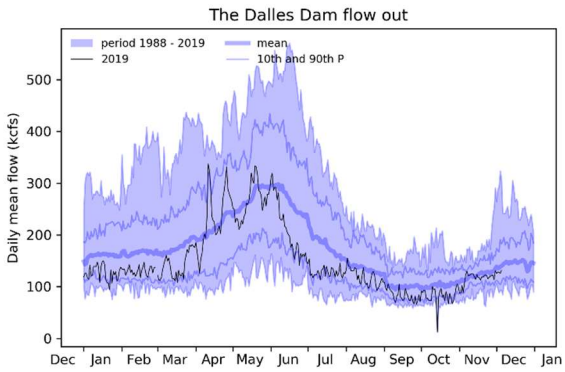


Figure 1: Daily outflow at Lower Granite Dam 1988-2019 *Figure 2: Daily outflow at The Dalles Dam 1988-2019*

Turner showed a video of the John Day tailrace on June 14, 2019. The video illustrated a change in conditions over approximately 20 minutes from spill at 142 kcfs (gas cap spill) down to 65 kcfs (performance standard spill). The video illustrated what a change in spill looked like.

The flexible spill agreement was implemented during spring on both the Lower Columbia River and Snake projects. The agreement called for 16 hours of spill to the spill cap and 8 hours of performance standard spill, daily (shown in the figure below). This operation was much different from those completed in past years. For instance, in 2018, the Corps was under court order to spill to the TDG cap at all projects.

The Corps follows a daily process each day during voluntary spill to set spill caps to "meet but not exceed." Each day during voluntary spill the Corps 1) Reviews data and flow/weather forecasts; 2)

Runs SYSTDG, as needed*; 3) Estimates maximum spill levels that meet but do not exceed the gas cap; 4) Coordinates with NOAA; 5) Notifies projects and BPA; and 6) Posts spill caps on web. They also engaged in coordination weekly with regional stakeholders like the Colville Tribe and USFWS at Technical Management Team meetings. Additionally, they generated reports monthly.

Project	Spring Spill for Juvenile Fish Passage			
	2017 (2008 BiOp)	2018 (Court Order)	2019 (Flex Spill Agreement)	2020 (Flex Spill Agreement)
Lower Granite	20 kcfs	120/115% TDG Cap	120% TDG Cap 16 hours 20 kcfs 8 hours	125% TDG Cap 16 hours 20 kcfs 8 hours
Little Goose	30%	120/115% TDG Cap	120% TDG Cap 16 hours 30% 8 hours	125% TDG Cap 16 hours 30% 8 hours
Lower Monumental	120/115% TDG Cap	120/115% TDG Cap	120% TDG Cap 16 hours 30 kcfs 8 hours	125% TDG Cap 16 hours 30 kcfs 8 hours
Ice Harbor	45 kcfs daytime 120/115% TDG Cap nighttime	120/115% TDG Cap	120% TDG Cap 16 hours 30% 8 hours	125% TDG Cap 16 hours 30% 8 hours
McNary	40%	120/115% TDG Cap	120% TDG Cap 16 hours 48% 8 hours	125% TDG Cap 16 hours 48% 8 hours
John Day	30% vs. 40%	120/115% TDG Cap	120% TDG Cap 16 hours 32% 8 hours	120% TDG Cap 16 hours 32% 8 hours
The Dalles	40%	120/115% TDG Cap	120% TDG Cap 16 hours 40% 8 hours	40%
Bonneville	100 kcfs	120% TDG Cap	120% TDG Cap 16 hours 100 kcfs 8 hours	125% TDG Cap or 150 kcfs 16 hours 100 kcfs 8 hours

Figure 3: Spill requirements by project 2017-2020.

This year there was very little involuntary spill during spring compared to the last few years. Total spill has increased overall since 2015.

Turner took TMT agencies and representatives through some project-by-project data. On Snake River projects, total spill was driven by planned (flex) spill and total flow. Overall, spill has increased over the past 5 years.

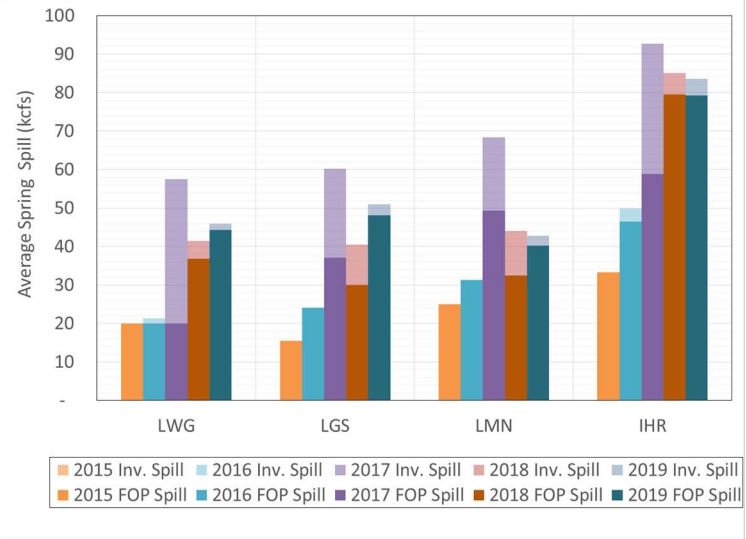


Figure 4: Snake River spill by project 2015-2019

At The Dalles, spill was changed to a percent of flow. There was also a joint spill operation between John Day and The Dalles. TDG generated at John Day was influencing The Dalles tailwater gage.

On the Columbia River projects, voluntary spill also increased overall over the past 5 years and total spill was influenced by total flow and planned spill.

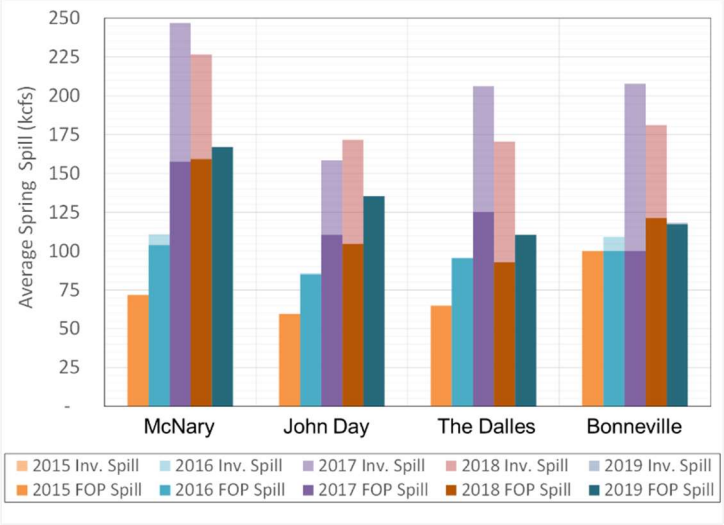


Figure 5: Columbia River spill by project 2015-2019

Turner showed a summary of adaptive spill management over the 2019 season. There were a few spill issues in 2019. At Lower Monumental, spill pattern had to be changed due to high TDG. There were spill and fish passage issues at Little Goose. There was 1 day in 2019 where all of the tailwater gages hit 120%. By date, important spill management decisions included:

April 8: Lower Monumental, performance standard spill, bulk to uniform spill pattern, TDG exceedance.
April 25: The Dalles changed the 120% TDG spill cap from a specific rate (kcfs) to a percent of total flow.
May 10: Joint spill operation with The Dalles and John Day initiated.
May 29: 120% TDG at all eight tailwater gauges.
May 29 to June 20: Little Goose adult passage issues (discussed elsewhere).

There was one data issue at The Dalles where a multiplier was added to barometric pressure. That data has been corrected. TDG values were originally reported as lower than what were was actually occurring, thus TDG went up by 1% when the data was corrected.

Moving forward into 2020, the flexible spill agreement calls for 16 hours of spill to the gas cap of 125% (up from 120% in 2019) and 8 hours of performance standard spill at all projects except John Day (120% on the 16-8 schedule) and The Dalles, which will spill at 40% at all hours. There is also a spill cap at Bonneville due to erosion concerns.

Turner shared some estimates for 2020 spring spill caps. The numbers he showed were estimates that will be change as the BiOp is finalized. The 2020 operation is new. Tailwater conditions will be different than they have in the past and those influence TDG.

The 2020 flexible spill agreement is still being finalized. Both states will have to reform their requirements.

Turner noted that in 2020, there is a possibility of resident aquatic life monitoring for gas bubble trauma and an increased risk of reaching thresholds, which trigger spill reduction.

Turner is nervous for 2020. Without knowing what the standards are going to be, agencies do not know what the data collection is going to look like, what the data review will look like, or who will determine if a threshold has been exceeded. How long would it take a decision to be implemented, he wondered. For instance, if he goes camping on Memorial Day weekend and data comes in to indicate that there is some gas bubble trauma, what would the process look like for the person working?

Erin Cooper, FPC, shared that there is not a huge lag between when data comes in to FPC about gas bubble trauma and when it goes online. However, different projects are sampled on different schedules so there can be several days of lag time in getting data. In the past, FPC has gone to FPAC if data was needed faster, for example if a spill cap was changed and action agencies wanted additional information to see if the change worked.

Scott Bettin, BPA, said normally GBT problems tend to increase in high flow years. This year there were turbines available to turn on.

Emily Stranz, DS Consulting, led a large group discussion on take-aways from TDG and the flex spill operation this year.

- Jay Hesse, Nez Perce, said a lesson was not having enough water to fully meet the gas cap. He wondered if it was possible to develop the instantaneous flow for each projects where minimum generation would be exceeded while meeting the spill cap. This would be with the caveat that spill cap estimates are wrong and that lack of market spill has not been accounted for. (Scott Bettin, BPA, pointed out it is possible to calculate that – looking at the minimum gen table in the FOP, you just add 11.5 to the 4 Snake project caps, 50 to John Day, McNary, and The Dalles, and 30 to Bonneville. Jay noted he was hoping someone else would do the calculation.)
- Laura Hamilton, Corps, said due to the huge change in spill operations for 2019, the water quality team had to do a lot of work to prepare for the season. She expects it will be the same this year. She noted it would be helpful to know how to respond to GBT triggers ahead of the season as it could influence preparations.
- Jim Litchfield, MT, would like to revisit the smolt survival data at John Day and The Dalles, as there were operational difficulties and changes in the operation.
- Erick Van Dyke, OR, echoed Litchfield's concern for additional analysis. He also noted that the team worked well together to adaptively manage in-season conditions.

4. SPRING CHINOOK PASSAGE – Dave Swank – USFWS, Charles Morrill – WA, Erick VanDyke – OR, Claire McGrath - NMFS

Dave Swank started the Spring Chinook Passage discussion with a presentation on timing and conversion. The conversation focused on adult Chinook counts between Lower Monumental and Little Goose over the 2018 and 2019 spill seasons.

Swank took TMT through metrics that track passage including daily window counts, and various PIT Tag count metrics, like daily cohort conversion rate. He shared some benefits and caveats of the metrics.

Swank showed TMT a graph summarizing 2019 adult spring Chinook passage from the Lower Monumental to Little Goose reach. The graph also shows the operations that occurred throughout the season.

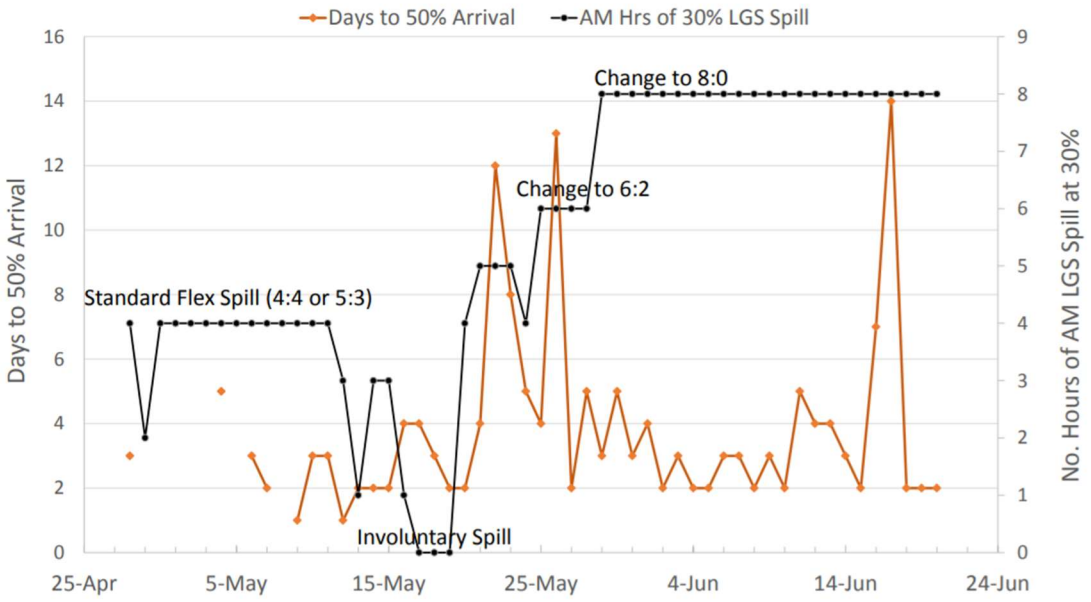


Figure 6: Spring Chinook survival, Lower Monumental to Little Goose April 25, 2019-June 24, 2019.

Swank shared a chart showing LMN to LGS Adult Arrival Timing and noted that the typical 50% arrival time is 1-2 days. This year it was 2-3 days. Overall conversion was slightly below years past, at 97.2% (in 2018, it was 97.7%). However, he said, once confidence intervals are factored in, the change in conversion to LGS is statistically indistinguishable.

Swank shared some insights from FPC Memo 24-19, which summarized adult impacts. Mainly,

- Travel times in excess of 20 days between Ice Harbor and Lower Granite Dams significantly reduced the probability that a wild origin spring Chinook would successfully reach their basin of origin,
- Being present during an identified period of operational impedance at Little Goose Dam was not a significant predictor of the probability of reaching hatchery/basin of origin for hatchery or wild groups in years 2005-2018, and
- Fish passing Lower Monumental dam when temperatures were above 62°F (hatchery), and 68°F (wild) had significantly lower probability of survival to hatchery/basin of origin than fish migrating in cooler temperatures.

Swank was surprised that the temperature for affecting survival of hatchery fish was 62°F. Swank showed harvest data for the Snake River and for below Little Goose. Anglers were aware of a slowdown at Little Goose. In 2018, the catch rate for adults and jacks was 0.025 (40 hrs/fish). In 2019, it was 0.07 (15 hrs/fish). Even with higher catch rates, the percent of adults harvested was

under the WDFW quota (though it dropped from 883 in 2018 to 331 in 2019). This year was a good example of fisheries management.

Swank reported on FPC Memo 30-18, which analyzed juvenile impacts. The memo noted that detections of subyearling Chinook occurred more often during night hours during one special operation. Dave showed a table with PITPH during the operation. Charles Morrill, WA, added the caveat that PITPH was not designed as an in-season tool.

He reminded TMT members that, "Not all fish passage delays are created equal." Factors that influence the importance of a delay include everything from the time of year to the potential for elevated mortality, in his opinion. While adults took longer to travel from Lower Monumental to Little Goose, annual conversion is minimally impacted.

This year, there were more "slow" fish than average. He wondered if it was related to the new operation and said an initial analysis seems like it is random but advocated for additional analysis.

Erick Van Dyke, OR, continued the discussion with a presentation on adult spring Chinook passage timing and conversion.

Van Dyke showed a figure tracking travel time for pit-tagged adult Chinook from Bonneville Dam to upstream projects in 2019 and 2014. The 2019 showed the variability of slower travelers. It was this "slow" group the spurred regional managers to make in-season adaptive management decisions. Comparatively in 2014, the trends for travel time reflect no "compelling difference," said van Dyke, even though the spill was based on the BiOp as opposed to flex spill operations.

Adults travel more river kilometers in a day in the Columbia River than the lower Snake, reported Van Dyke. He suggested that the data may indicate that fish slow as they enter the Snake, regardless of spill operation.

Overall, adult cumulative passage percentage to Lower Granite Dam exceeded 95% and were within a spread of 2.7% 2014–2019.

Van Dyke then gave a brief history of Little Goose adult Chinook salmon passage. During the overview, he discussed several studies, including Haynes and Gray (1980) and Jepson et al. (2009). Studies before 2006 indicate that dams on the Snake and Columbia rivers slow upstream migration of adult salmon and steelhead. A few key takeaways were that ladder counts generally increased during periods of higher discharge and that some active studies indicate that adults prefer the north shore of Little Goose.
He summarized FPC memo 47-18, which stated that travel time does not seem to have negative effects on final conversion to Lower Granite. He cautioned that when making decisions, downstream passage should be considered, per the memo. And, when it comes to specific operations, Van Dyke shared FPC's view that TSW operations seem to negatively affect adult passage rates.

Key takeaways from the 2019 season included that Little Goose operation changes meant to address adult passage concerns increased PIT PH at more than Little Goose Dam. Additionally, Van Dyke would like to see additional evaluation on what operations could help survival.

Van Dyke highlighted efforts to work collaboratively in season. Looking forward, he shared that increased spill will likely decreased powerhouse encounter probability, which will increase SAR, thus increasing adult return.

Charles Morrill, WA, presented next on spring and summer Chinook adult ladder counts. Ladder counts are best used as an in-season tool and do not account for fallback or re-ascension. Morrill was not able to find a way to definitively adjust daily adult counts for fallback or re-ascension. Thus, knowing the data is imperfect, Morrill shared that there were 494 Unique PIT Tags Detected at LGO, (on average, 8 were detected per day). Of the PIT Tags identified at LGO, 51 fallback/re-ascensions were counted. That said, Charles Morrill, WA noted that weekly count totals can be adjusted and used to correct total passage and in-season conversion rates.

This year, there were 382 hatchery pit-tagged adults with known origins. The harmonic mean travel time for those fish was 2.9 days and the median was 2.7 days. About 7.1% of fish took ≥ 18 days to travel from Lower Monumental to Little Goose.

Morrill discussed returns and harmonic means of several release groups. Overall, this data showed short travel times with a few outliers.

Looking at wild fish, 96 were detected with known origins. The mean travel time for all wild origin Chinook was 2.4 days and the median was 2.8 days (slightly faster than hatchery fish when looking at the mean time and slightly longer when looking at the median). Like the hatchery data, 7.3% of fish took ≥ 18 days to travel from Lower Monumental to Little Goose.

The takeaway, Morrill said, was that there are fish that move slower and fish that move faster and balancing that need is an in-season adaptive management decision.

Claire McGrath presented for NOAA. Claire discussed travel times from Lower Monumental to Lower Granite and Ice Harbor to Lower Granite, which were slower than expected at times; convergence rates; and fishing pressure. NOAA worked with the Northwest Fisheries Science Center to develop some analyses for today's discussion, including a compass simulation.

McGrath agreed with what Charles Morrill, WA, noted earlier, that looking at raw counts gives different results than pit-tag data. Most of that convergence can be pinned to fallback and re-ascension, she said.

Looking at the timing of fish entry at Ice Harbor to Lower Granite compared to previous years (2013-2018), fish entry was "intermediate." While passage slowed over the season, it still tracked in the middle of the 2013-2018 data. It was not outside of the range of previous years.

Around May 20-25, fewer fish were converting, McGrath reported. However, there were small sample sizes this year so it took just a few data points to push things out of the expected range.

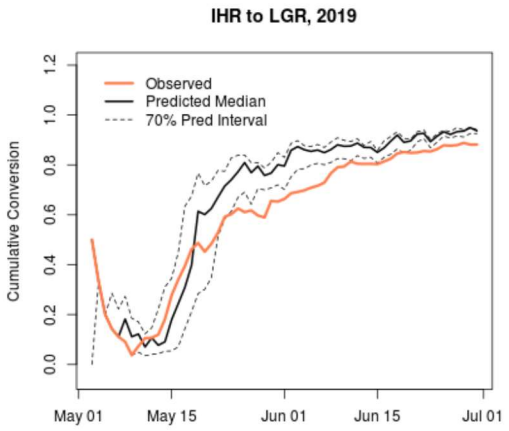


Figure 7: Conversion rates at IHR to Lower Granite May-July 2019

Looking at Little Goose to Lower Monumental, arrival timing was intermediate compared to 2013-2019, as well, but travel time, in days, was slower than recent years.

NOAA wanted to know the effects on juveniles so they reached out to the Northwest Fisheries Science Center about COMPASS, which allows researchers to compare hydro system survival across management scenarios. McGrath offered to share the manual for COMPASS with anyone interested. The model is specific to Snake River Chinook and Columbia and Snake Chinook and validates well.

NOAA ran a range of potential outcomes on juveniles using different adult management strategies under various river conditions. COMPASS showed in a gas cap scenario of 125% the only real difference was in spilling in a 12-hour block (compared to baseline, an 8 hour block, and an 8-12 hour block), which resulted in a decrease in fish passing. Looking at Little Goose project survival, survival was influenced greatly by the water year. The dry year yielded much lower survival rates. Looking at management decisions within the water years for Chinook, very little could be done to change in-river survival. There was also little difference in travel time. Steelhead models yielded similar results.

FPC came out with a memo saying that fish can have travel times up to 20 days without changing survival upstream. McGrath had questions about the definition of detection and sample sizes since typically fish managers have not liked delays. They asked to look further at the data and a paper will be available within a few days. The paper looks to address three things:

1. How do conditions at Little Goose Dam affect travel times from Ice Harbor to Lower Granite?
2. How does travel time at three spatial scales within the hydro system affect apparent survival to spawning tributaries?
3. Can we detect an effect of conditions at Little Goose Dam on upstream survival directly?

The data showed higher spill proportions increase travel time and are associated with lower upstream survival. Temperatures above 18 °C are associated with longer travel times and lower upstream survival. The range of spill operations at LGS considered in 2019 and 2020 had little to no effect on juvenile travel time or project survival in COMPASS simulations.

Additional details and models are available in McGrath's presentation on the TMT website and in the paper, which will be released shortly.

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Questions:

- Dan Turner, Corps, asked for clarification from Erick Van Dyke on how it is possible for PITPH at Little Goose to increase PITPH at other projects and what that means. Erick Van Dyke responded, "PITPH was designed for the system." Erin Cooper, FPC, added, "When you are ponding at Little Goose because you've reduced spill to 30%, you are also increasing PITPH at downstream projects." FPC did a study and found that ponding at Little Goose affects powerhouse passage at Lower Monumental.
- Doug Baus, Corps, asked about COMPASS and if there is model validation (in relation to NOAA's presentation). Steve Smith, NOAA NW Fisheries Science Center, mentioned that there is calibration based on new data.
- Ann Setter, Corps, asked Erick Van Dyke about travel time factor and its relationship to final conversion. She asked him to comment on 2014-2019. She also asked how relevant it is to watersheds in Idaho that are critical and are having issues getting spawners back up. Idaho and Nez Perce tribes track conversion, annually, Ann said. Over 2014-2019, the operations were different, Ann said, which is why she would in interested in overall final conversion year-by-year versus 2019 and the difference there. Erick Van Dyke responded that it is a work in progress and that evaluation is still being thought about and the he does not have an answer. Claire McGrath, NOAA, said she could look through the Siegel and Crozier (2019) analysis and provide a year-effect estimate and a population estimate. "Getting fish to Lower Granite is the first step," she mentioned, adding that "when" seems to involve different viewpoints. Ann asked if flow makes a difference to when fish get to Lower Granite. McGrath replied that it does and was included in all the models in the study. Flow affects survival in two ways, said McGrath: 1) Having a high flow year will increase survival and 2) High flow years decrease detection probability at some sites, like the middle-fork Salmon River. Jay Hesse, Nez Perce, added that the end game is not just about conversion but should also include the harvest rate for tribal members. Thus, the terminal area fisheries are contingent upon the fish arriving in a timely manner, he said. This is not only for harvest but fish quality. "They may all make it later on, but that's still no okay," said Hesse. "We've got to get them there in a natural timeframe."
- Erick Van Dyke commented that it seems like once fish slow down at the first site, they do not speed up but rather continue to be slow. He says that raises questions. One of those questions is that TMT focuses on the slower moving group in its decision-making and can overlook the bigger functionality of travel through the system. He said he is not sure that every fish needs to make it to the fishery faster.
- McGrath mentioned that the slower moving fish have been referred to as "outliers" by a few people during today's meeting. She noted that they are more accurately fish at the end of a skewed distribution, because travel time is a skewed distribution by definition.
- Ann Setter had questions about slow movers versus fast movers and the relation to ocean conditions. McGrath replied that later arrival does play into things, as does warmer migration temperatures. Paul Wagner, NOAA, added that Siegel and Crozier found that as fish are delayed they experience lower flows and higher temperatures (as seen in 2018).

- A question not answered, was if a fish is an early entrant, is it a slower mover and if it is a later entrant, is it faster? Paul Wagner did not know the answer off the top of his head. (Ann asked the question) Steve Smith shared that run timing is heritable across populations. He said a correlation may not be there.

Emily Stranz led a large-group discussion on takeaways based on the above presentation. Takeaways are documented in the facilitator's notes and include:

- Once fish start moving slow, they stay slow, according to Erick Van Dyke, OR.
- McGrath, on the other hand was careful to note that it is hard to wholesale that a slow fish is a slow fish because pit tag data shows that fish that moved slowly from Ice Harbor to Lower Monumental pick up speed through Lower Granite and can actually be the fastest fish. This is a really good illustration of data sources and points of agreement. McGrath mentioned there may be some benefit to looking at the DART tool and delving into if the 3-day metric is best, the 4-day metric or if the group should not use any means at all. She also wondered in the case of slow fish if anything can be done from a management perspective to help them. One of the big questions is if those slower fish should be managed for or not.

5. SMOLT SURVIVAL AND TRAVEL TIME AND TRANSPORTATION ANALYSES – STEVE SMITH NOAA NMFS Science Center

Steve Smith, NOAA NW Fisheries Science Center, presented on 2019 migration conditions, 2019 smolt travel time and survival, smolt-to-adult return rates (SARs) for transported smolts vs those that were bypassed to continue migrating in-river in 2015-2017. Juvenile passage timing is affected by multiple factors including flow, temperature, and spill. In spring of 2019, flows were above average throughout the season and spill was above average (vs 2006-2018). Water temperature was near average overall but fluctuated. Travel times for yearling Chinook early in the season were longer than in other recent high-flow years. For steelhead, travel times in 2019 were similar to those in other recent high-flow years.

For 2019, PIT-tag survival estimates for yearling Chinook were below average in the Snake River and above average in the lower Columbia River. Steelhead were average in the Snake and below average in the Columbia. Sockeye survival was near average in both reaches.

PIT-tagged fish are released from hatcheries in the Snake River basin upstream of Lower Granite Dam, and in the upper Columbia River basin upstream of McNary Dam. Estimated survival for these hatchery fish have been relatively steady for 20 years, but were 5-10% lower than average in 2019. Yearling Chinook released from Pahsimeroi Hatchery had particularly low survival, most likely because of an outbreak of bacterial kidney disease (BKD) shortly before the release date. Omitting that particularly low estimate, the average survival for the other hatcheries was still below average.

Smith took TMT through several graphs showing daily flow, daily temperature, daily percent spill, daily TDG, and passage timing of wild and hatchery Steelhead and Chinook.

Smith also presented on results of smolt transportation. He presented on Yearling Chinook and steelhead using data from smolts that migrated 2015-2017, updated with adult returns through December 5, 2019. He focused on smolt-to-adult return ratios (SARs) for transported vs. in-river (bypassed) fish at the three Snake River collector dams, Lower Granite, Little Goose and Lower Monumental. The smolt migration year 2015 had low flow, high spill and above-average

temperatures; 2016 had average flow, average spill and warm temperatures; and2017 had above-average flow and spill and average temperatures.

The basic question addressed by this research is the temporal pattern within migration seasons in the difference in SARs for fish that were transported vs. bypassed (T:B ratio) after entering juvenile bypass systems (JBS) as smolts. This requires a time stamp that identifies when a smolt was detected in juvenile bypass system. These analyses use fish that entered JBS at LWG, LGS, or LMN, including those tagged upstream of, or at Lower Granite. The data provide a seasonal analysis of SARs through the season. Note that using PIT-tag data, it is impossible to distinguish between mortality and permanent straying.

One challenge in the data is that there are groups of smolts that have 0 adult returns. Traditional methods give the same estimated SAR of 0% in this case regardless of the number of Smolts in the group. An alternative method known as "median unbiased estimation" preserves the information carried in the sample size: 0 adults returning from a large number of smolts gives a lot more information about the true SAR than 0 adults from a very small sample.

For Wild Chinook, relative to the average since the beginning of court-ordered spill in 2006, T:B ratios were high (transported fish had higher SARs than bypassed fish) for 2016 and very high for 2015. For smolts from 2017, relatively few adults have returned, SARs were low for all groups, T:B ratios for wild Chinook were lower, and estimates were imprecise.

For Wild Steelhead, the year-to-year pattern is quite different from Wild Chinook: T:B ratios for 2015 smolts were unusually low, in fact one of the few years when bypassed SARs were higher than transported. Results for 2016 and 2017 migrants were more typical, with transported fish returning at roughly twice the rate or more than bypassed fish. In addition, SARs for 2017 were not unusually low.

Results tend to be similar for Lower Granite and Little Goose Dams. Together, they account for about 75-80% of all transported fish. Things tend to be more variable at Lower Monumental due to less available data. Typically, Lower Monumental has a lower T:B ratio, meaning transportation is not as beneficial from Lower Monumental as it is from Lower Granite and Little Goose.

Historically, T:B ratios often increased throughout the season, and were often less than one (bypassed SAR higher) in early April. In recent years, transportation has started later in the season, and T:B ratios have been more constant. The data also shows that fish are migrating earlier. A higher proportion are migrating in April. Fish migrated earlier this year, as well. Smith is working on a synthesis report of multiple years of T:B data, which should be reported next year (2020-2021).

Questions and Comments:

- It is worth noting that the Snake River trap was not operational for a time in spring 2019 because of high flows, and no fish were tagged there between 09 and 18 April. Thus, this would affect one of the points in Smith's presentation of survival of Chinook from the Snake River trap to Lower Granite. The Snake River trap is estimated based on data available. Though it is possible that the effect of the missing data was a biased survival estimate, Smith said that the bias could have been either an under- or overestimate. This has been an issue in the past, particularly in 2017, when the trap was inoperable after two days in early March.

- Ann Setter asked if the smolt migration timing was related to the timing of the hatchery releases. Smith did not know the answer. Hesse said hatchery releases are being adjusted and are a variable that should be taken into account. He said releases were later than normal, if he remembers right. Hatcheries have been holding fish longer to make sure they do not get released before screens and transportation. In 2019, many fish came down during a large water week in the second week of April.
- Scott Bettin, BPA, asked if flows were known would managers have started transport earlier – "loaded the trigger" so to say, instead of waiting? Smith said no, it is more beneficial to put them on a barge when the flow is low.
- Jim Litchfield, MT, would like to see a way the information Smith shared could be used as a way to evaluate operations. Smith mentioned that there is only one year of flex spill thus far, and it will be a couple of years before adult data is available for those fish. He further noted that there were no dramatic indicators in the smolt migration data.
- Doug Baus, Corps, commented that the results of this year's spill are not surprising based on tailrace hydraulics in the form of eddies that are associated with high rates spill relative to powerhouse outflow. As he thinks about where we are and where we are headed he thinks it is something we should continue to monitor when there is low juvenile survival below projects that have eddies in the tailrace.
- Steve asked Dan and Doug if there are particular reaches (tailraces) in which smolts might be particularly delayed. He mentioned that he mostly looks at long regions and reaches for comparison. Scott Bettin, BPA, mentioned John Day.
- Dave Swank, USFWS, mentioned that in a different study, travel times were actually short. Smith clarified that what he notices was that travel times for Chinook in April under high flows were up to 6 days longer than they were in 2017 and 2018, which were also high-flow years. Steelhead travel times were only 0.5-1 day longer. In May 2019 both Chinook and steelhead had travel times similar to those in 2017 and 2018.
- Ann Setter wondered how Faulkner's paper plays into the data being currently discussed. Bogner's paper says that fish are smaller when they are collected by screens and potentially when they are being transported.

- There were different management intentions this year compared to 2017 and 2018. While 2019 was properly classified as "high spill," high flows meant that the percentage of flow spilled was actually lower than in the previous two years.
- Should summer transport, for summer-migrating subyearling fall Chinook salmon,start July 1? It may be helpful to have additional meetings on that. There was one meeting scheduled but it did not happen.
- Over the past few years, smolt runs have been earlier and earlier, said Dave Swank. At some point, it may be worth looking into how the periods are defined and managed. This could have financial implications and run into maintenance periods. A place for these discussions may be FPOM and more conversations may be needed before this becomes a TMT issue.
- On a similar note, there may be broader implications of earlier movement. – Ann Setter, Corps
- There seems to be a disconnect between these types of forums and the hatcheries, as these forums talk about them but they do not have a voice in these discussions, noted Ann.

6. OVERALL TAKEAWAYS AND POINTS FOR ADDITIONAL DISCUSSION:

Emily Stranz, Dave Swank Consulting, led a discussion on 2019 takeaways. Some points mentioned were:

- Additional clarification is needed regarding the RIOG/TMT/Flex Spill teem coordination and elevation process.
- Jim Litchfield, MT, wondered if there is a way to check in-season how each of the projects are doing with increased spill. Jim noted that typically the data does not come in until TMT YER when Steve Smith shares the data with action agencies and representatives. However, it is possible to observe flows such as eddies and Jim wonders if there is a way to incorporate that in to in-season decisions. Video may be key here.
- TMT members and agencies expressed interest in an on-site visit to a project.
- NOAA noted that the Nez Perce did an excellent job expressing concerns this season and providing solutions.

Things TMT did well:

- Thumbs up to Claire summarizing observations in real time at Little Goose in season rather than waiting until December.
- Thumbs up for better collaboration and cooperation among TMT members and agencies, for instance during chum operations.
- Thumbs up from NOAA to the Corps and FPC for summarizing TDG information in-season.
- Thumbs up to Doug and the Corps for organizing TMT meetings.
- Thumbs up to the facilitator for managing meetings and directing conversations.
- Thumbs up for using FPC, DART, etc. in making in-season decisions.
- Thumbs up for process meetings, which have been a helpful tool, said Charles Morrill, WA.

Areas for improvement:

- Choose either C° or F° for temperature unit. – Dan Turner, Corps
- Thinking about long-term solutions.
- Writing down routine operations, which may make in-season operations more efficient.

Today's Attendees:

Agency	TMT Representative
Army Corps of Engineers	Doug Baus (Chair)
Bonneville Power Administration	Tony Norris, Scott Bettin
Bureau of Reclamation	Joel Fenolio
NOAA Fisheries	Claire McGrath, Paul Wagner
US Fish & Wildlife Service	Dave Swank
Washington	Charles Morrill
Oregon	Erick Van Dyke
Idaho	N/A

Agency	TMT Representative
Montana	Jim Litchfield
Nez Perce Tribe	Jay Hesse
Umatilla Tribe/CRITFC	N/A
Colville Tribe	Sheri Sears
Warm Springs Tribe	N/A
Kootenai Tribe	N/A
Spokane Tribe	N/A

Other Attendees (non-TMT members):

Army Corps of Engineers –Alexis Mills, Dan Turner, Steve Hall, Jon Roberts, Laura Hamilton, Heather Baxter, Ann Setter
DS Consulting – Emily Stranz (Facilitator), Colby Mills
FLUX Resources – Melissa Haskin (Note taker)
Columbia Basin Bulletin – Mike O'Bryant
Yakama Nation Fisheries – Tom Iverson
NPPC – Leslie Bach
NOAA – Trevor Conder, Josie Thompson
Reclamation – Peter Cooper
NOAA NW Fisheries Science Center – Steve Smith
Fish Passage Center – Erin Cooper, Gabe Scheer
EGPS – Joshua Rasmussen
ODFW – Tucker Jones
NWPCC – Jeff Allen