NWE-THF-3773

Ms. Kimberly D. Bose
Secretary
Federal Energy Regulatory Commission
888 First Street, NE
Washington, DC 20426

April 1, 2020

Re: NorthWestern Energy Files Structured Scientific Review of the Fish Passage at the Thompson Falls Hydroelectric Project (1869)

Dear Secretary Bose:

The Commission issued an Order dated February 12, 2009 approving the construction and operation of the Thompson Falls Fish Passage Facility (Passage Order). Included in this Passage Order were the US Fish and Wildlife Service (USFWS) Terms and Conditions (TC). TC1(h) required NorthWestern Energy (NorthWestern) convene a structured scientific review of the fish passage project, guided by a Technical Advisory Committee (TAC) made up of representatives from the USFWS, Montana Department of Fish, Wildlife & Parks and the Confederated Salish and Kootenai Tribes.. The scientific review was to develop a set of recommendations to be submitted to the USFWS for evaluation, modification, and approval.

On April 1, 2019, NorthWestern filed a request with the Commission to amend the requirements included in the Passage Order. Specifically, NorthWestern requested the date for reporting on the results of the scientific review be changed from April 1, 2021 to April 1, 2020. The Commission subsequently approved this request under an Order issued October 7, 2019.

NorthWestern convened an independent scientific panel (Panel) in consultation with the TAC and the Panel has completed its scientific review of the fish passage project. Herein attached are the Panel's review and recommendations as submitted to the USFWS.

Sincerely,

Mary Gail Sullivan
Director, Environmental and Lands

CC: Andy Welch, NWE
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MEMORANDUM

To: NorthWestern Energy & Thompson Falls TAC

From: Thompson Falls Scientific Review Panel

Date: March 27, 2020

Re: Thompson Falls Fish Ladder Review

Introduction

In 1912, the Montana Power Company began construction of the Thompson Falls Hydroelectric Project (the Project) on the Clark Fork River, adjacent to the town of Thompson Falls MT. Because it is a non-federal hydropower project, the Thompson Falls Project is regulated under the Federal Energy Regulatory Commission (FERC), under the authority of the Federal Power Act. The original FERC License for this project expired in 1975 and the current license was issued to Montana Power in 1979. In 1999, the Project and License were purchased by PPL Montana. A major order amended the license in 1990 for the construction of an additional powerhouse and generating unit. Construction of the new infrastructure was completed in 1995 and increased the generating capacity of the Project to 92.6 megawatts. NorthWestern Energy purchased the Project in 2014. The current FERC License is scheduled to expire December 31, 2025.

Bull Trout were officially listed as a Threatened Species on June 10, 1998 and Critical Habitat was formally adopted in the vicinity of the Project on September 26, 2005 (USFWS, 2008). Because of the presence of Bull Trout in the Project area, a Biological Evaluation (BE) was developed to assess the impact of the Thompson Falls dam and powerhouse on Bull Trout and to make recommendations about conservation measures to reduce any impacts. The BE concluded the Project was likely to adversely affect the Bull Trout. After five years of research and evaluation, PPL Montana proposed to move forward with the development of an upstream adult fishway. PPL Montana provided FERC with a supplemental BE, filed on August 22, 2008, further detailing construction plans. The BE was adopted as FERC's final Biological Assessment (BA) and submitted to USFWS on May 1, 2008 with the request to initiate formal consultation under the Endangered Species Act. USFWS filed a Biological Opinion (BO) and Incidental Take Statement in November 2008 and FERC issued an Order Approving Construction and Operation of Fish Passage Facilities for the Thompson Falls Hydroelectric Project. The Order included the reasonable and prudent measures, Terms and Conditions and conservation recommendations from the USFWS' BO.

Two of the Terms and Conditions (TC1(g) and TC1(h)), led to the convening of a Scientific Review Panel to evaluate multiple questions on the fishway, listed in bold below along with the Panel response, that were proposed by the Technical Advisory Committee (TAC). The panel was also instructed to "identify gaps, further information needs, or recommendations for potential changes in the ladder structure, hydraulics or operation" (NWE, 2019).

The Scientific Review Panel consisted of:

Brett Towler, Fish Passage Engineer, US Fish and Wildlife Service, Sunderland, MA

David Schmetterling, Fisheries Research Coordinator, Montana Fish, Wildlife and Parks, Missoula, MT

Elizabeth Erickson, Principal Hydrogeologist, Water & Environmental Technologies, Butte, MT

The panel began its work with a kickoff conference call on January 17, 2020. During the data review portion of the project, weekly calls between panel members were scheduled to discuss the questions presented and any questions or issues that developed. It became apparent in our first conference call discussion on January 30, 2020 that a definition of effectiveness was required to evaluate the data presented. An inquiry was forwarded to NWE on January 31, 2020 to clarify if a standard for effectiveness was considered in the TAC development of Question #1.

The TAC response received on February 12, 2020 is shown below:

"Within the action plan there were details for evaluating the ladder but a standard for effectiveness was not defined.

Through the years there has not been explicit goals stated relative to quantitatively measuring success. There was reluctance during the planning phase of the ladder to have a numerical standard because of the unknowns of how fish (bull trout and others) would interact with the ladder, due to BT low overall abundance, and no existing ladders designed to pass BT or standards relative to fish ladder construction for BT.

The goals that have been defined were qualitative and established during the ladder design and construction process which include:

1) *The ladder is designed to operate when total river flows are under 48,000 cfs.*
2) *Goal of ladder operations to capture (priority):*
    1. *Bull trout*
    2. *Native fish*
    3. *Non-native sport fish, namely rainbow and brown trout.*
3) *Goal to attract fish from the main dam apron over to the ladder entrance.*

These overarching goals were used by NWE and the TAC to guide ladder operations and data collection efforts on an annual basis. Based on these goals we would propose that an abridged version for the current standard for effectiveness would be <u>"ladder is successful in passing upstream motivated adults that are near the main dam apron in a safe and timely manner"</u>.

The TAC agrees that this standard is vague and sees the value in refining a standard, and better defining terms such as upstream motivated, timely, and safe. The goals we have been operating under are qualitative in nature and therefore a challenge to evaluate relative to success. Given our predecessors direction, and what is written in the BiOp, current evaluation of operations and assumptions made during the design should be evaluated under the provided standard. The TAC would request the panels guidance on how to refine a standard moving into the future that is reasonable, along with methodologies to investigate how the ladder is performing relative to a more quantitative approach.

Thus, the Panel moved forward using the TAC standard for effectiveness to address the questions posed, but also developed, based on their experience, a framework for a quantifiable definition of effectiveness to be used moving forward. In many instances the Panel had difficulty answering the 5 questions provided and instead identified additional data needs and the techniques available to collect the data.

Before moving into the actual questions and responses, a framework for the definition of effectiveness will be provided for consideration in future evaluations and for reference to the questions and responses shown below.

The definition of effectiveness should be both quantifiable by project components and measurable, either directly or indirectly to be useful to NWE and the agencies in an effort to achieve the identified biological outcomes. Secondarily, the definition of effectiveness should be consistent with the "Safe, Timely, Effective" paradigm used by FERC and the federal resource agencies.

The Panel recommends the adoption of PROPORTION-TIME-EFFECT metrics to quantify effectiveness. These metrics are defined as follows:

- PROPORTION: quantify efficiency in 3 parts (attraction/entry/internal)
- TIME: quantify delay acceptable to (or associated with) efficiency metric
- EFFECT: fish are safe; not injured

An example of the use of these metrics is:

> X% of Bull Trout approaching within Y meters of the ladder entrance successfully (attract*entry*internal) pass within Z days without experiencing N% descaling rate.

Several precedents exist for implementation of this approach and they were described at the Panel meeting in Missoula on March 10, 2020. They include the Milford Project on the Penobscot River in Maine for Atlantic Salmon (Black Bear Hydro Partners, LLC 2012) and the Conowingo Project on the Susquehanna River in Maryland (USFWS 2016) for American shad.

The Zone of Passage (ZOP) Concept was also used in the analysis completed for the Thompson Falls Project. The concept, as illustrated in Attachment A, defined discrete areas for analysis at the fish ladder. Attachment A is an example showing the important loci and their definition and an example of what the loci might look like for the Thompson Falls. The ZOP approach may be advantageous in identifying how and where to measure effectiveness, and attributing causes and influences (project and non-project related) to effectiveness issues

With this framework in mind, the Panel offers the following response to the 5 questions posed.

Question 1: Ladder effectiveness (ability of fish to locate the ladder once they are in the zone of influence)

a. **Considering available information, does it appear that the ladder entrance is effective for capturing upstream bound Bull Trout?**

The current practice is to partition effectiveness into attraction efficiency, entrance efficiency, and internal efficiency. From "zone of influence", we infer this question is asking about attraction and entrance efficiency only.

Between 2011 and July 1, 2019, roughly 32,000 fish ascended the ladder, including 17 Bull Trout (NWE 2019). Over that same time period, 3217 salmonids have been recorded at the ladder and Rainbow Trout are the most frequently caught salmonid.

The numbers of Bull Trout passing through the ladder are not sufficient to judge efficiency (annual number of Bull Trout captured at the ladder range from 0-5). Although other species have passed in greater numbers (e.g., Rainbow Trout), their utility as surrogates for Bull Trout passage have not been established by the TAC. Ideally, entrance and attraction efficiency can be deduced from radio telemetry, passive integrated transponders, hydro-acoustics, and other biological evaluations of a sufficiently large sample. Telemetry was performed prior to ladder construction, and thus, offers no insight.

Hydraulics, and more specifically velocity fields, can be used as indirect indicators of effectiveness. For example, species-specific swimming capabilities can be compared with velocity fields at or near the entrance to infer effectiveness. Compared to Pacific salmon (for example), there is less information available on Bull Trout swimming performance, though it is reasonable to assume that Bull Trout performance (like many salmonids) can be related to body size, especially fish length. However, no information on the velocity fields at or near the entrance is available.

Due to the lack of biological evaluation and hydraulic data on the ladder entrance, the Panel cannot offer an opinion on the ladder entrance effectiveness at this time.

b. **Are there entrance modifications that could increase the effectiveness to get fish into the ladder?**

Although the current effectiveness of the entrance is unknown, it is likely that improvement (perhaps even minor ones) can increase the effectiveness. Broadly, the types of enhancements may include structural changes (e.g., rounded edges to eliminate flow separation that may produce an adverse behavioral reaction in Bull Trout) or operational changes (e.g., altering gate openings to create more flow depth or higher velocity). For example, at the Mactaquac hydroelectric development on the St. John River in New Brunswick, Canada (Towler 2019), evidence suggests that salmonids enter the fishway at a faster rate when the depth of flow at the entrance is 1 meter or more. These modifications can range from the simple and inexpensive to complex and cost prohibitive. However, in the absence of any biological evaluations or hydraulic data, specific recommendations for modifications cannot be made at this time.

Furthermore, since Bull Trout are especially prone toward migrating at night, the use of lights at the entrance way could dissuade attraction to, entrance of and use of the fishway.

c. **Considering available research, does the panel have concerns regarding Bull Trout time to approach or find the ladder entrance?**

Virtually all fishways create some delay in movement (though ideally the delay is not biologically significant). In general, a 24 to 48-hour delay is considered acceptable. A 48 to 72-hour delay is typically something to avoid; however, this is species dependent. Salmonid migrations are more episodic than other species, thus more forgiving of minor delays as fish search for the entrance. Nevertheless, there is insufficient data to determine if delays at the fishway entrance are concerning. More information is needed.

d. **Is there adequate information regarding attraction flows to move fish to the ladder at varying river flows, within the range of designed flow?**

There are 3 major influences of a fishway entrance: location, flow and velocity. Telemetry studies performed prior to the construction of the ladder suggest Bull Trout may stage at the abutment on river left. Since the fishway was constructed on river right, this creates an inherent challenge to lure the fish to the fishway entrance via flow and velocity.

At this time, there is insufficient information to determine if the flow and velocity are adequate to attract fish to the ladder. Current methods to assess the flow and velocity fields include direct measurement (using acoustic doppler velocimetry or comparable technologies) or computational fluid dynamics (CFD). The development of a 2D (depth averaged) CFD model to assess velocity field downstream of a fishway would assist NWE and stakeholders in understanding if;

> a) the flow field created by discharge from ladder creates a sufficient behavioral cue to Bull Trout (and other species), and
>
> b) whether velocities are low enough as to not fatigue fish attempting to approach the ladder entrance.

Regarding the varying river flows, it is important to consider the impact that a limited operating range has on the effectiveness of a fishway. Conventional practice is to assume that migrating fish will move in all but the highest and lowest flow conditions. The USFWS and other federal and state agencies define this upper and lower design flow as the river flows that are equaled or exceeded 5% and 95% of the time, respectively. Fishways that are designed to function under these conditions can be effective during 90% of the migratory period. Based on an assumed Bull Trout migratory period of March 15 through October 15, the 5% exceedance (i.e., high design flow) at Thompson Falls is 66,000 cfs. However, the ladder only operates up to 48,000 cfs which correlates to an exceedance probability of 12%. Thus, the ladder is unavailable for passage and ineffective 7% of the migratory period. From 1990 to 2019, there were 43 such multiple-day high flow events. The impact on passage is not clear, but may manifest as an unacceptable delay or even failure to pass the dam. For example, 48,000 cfs correlates to the 45% exceedance level in June. This suggests that the ladder is not functional approximately half the time during the month of June.

Bull Trout primarily move in the Spring and to some extent, in the Fall close to spawning time. During the summer period, say mid-July through mid-September, they would not generally be moving through this portion of river. So, by including this in the operational period, the actual effective period is inflated, since during that time that ladder is typically operational, but there is no Bull Trout movement.

e. **Given larger sample sizes of other (not Bull Trout) salmonids in the system what conclusions related to ladder effectiveness can be made?**

Swimming performance of Bull Trout is not well known. However, more information is available on Rainbow Trout, which may serve as a (swimming capacity) surrogate for Bull Trout. Assuming Rainbows can be used as a surrogate for Bull Trout, one could then adjust swimming performance by body length. As a general rule of thumb, the sustained swimming speed of most carangiform/subcarangiform forms is 4 to 7 times its body length. Given the size of Bull Trout (vs the other species moving through the ladder) and the number of smaller Rainbows passed, it's reasonable to assume that water velocity-swimming speed is not a limiting factor for Bull Trout. However, behavioral differences between Bull Trout and the other species (which move in larger numbers through the ladder) may mask effectiveness issues.

Here are some general thoughts on surrogates: In general, Bull Trout are the largest salmonid, migrate at night, adhere to the river margins more than other salmonids and have a more protracted migration period (bi-modal) than other salmonids.

Rainbow Trout

- Migration period is earlier than Bull Trout, so timing might be restrictive.
- Smaller in body length than Bull Trout, so jumping ability and maximum swimming velocity would be less.
- Migrate in the daytime, so lights, and other nighttime disturbances might not be a factor.
- Migration period that is shorter than Bull Trout.
- Use margins during high, turbid flows, but may use mid channel more during lower or less turbid flows than Bull Trout.

Westslope Cutthroat Trout

- Similar physiologically to Rainbow Trout.

- Migration period is later than Rainbow Trout and coincides more closely to Bull Trout, but just in the spring.

Brown Trout

- May be more closely sized to Bull Trout so jumping, and swimming abilities may be similar to Bull Trout.
- Migrate in summer and fall, so they could be effective surrogates for the fall (Sept-October) migration period for Bull Trout.

f. **Are additional studies needed (not already planned) to assess ladder effectiveness?**

Additional studies are needed to assess effectiveness. Whereas the Panel has provided NWE with an extensive list of potential data needs, two needs in particular are critical: telemetry and CFD. A 2-dimensional CFD model of the river downstream of the dam can be combined with telemetry studies on a limited number of fish (surrogates or Bull Trout) and may provide valuable insight into the effectiveness of the ladder in both the far and near fields.

Question 2: Within ladder operations:

a. Considering available research, does the panel have a recommendation for running the ladder in orifice or notch mode to maximize the catch of Bull Trout? Are additional studies needed (not already planned) to assess ladder operations?

At this time, no. The other issues are of greater concern.

b. Are the PIT tag antenna arrays within the ladder capturing sufficient data to determine fish movement within the ladder?

Although, issues related to internal passage effectiveness are both the simplest to solve and identify, they are low in priority, as compared to the other identified issues at this site. Multiple PIT loops are recommended to evaluate both entrance modes, and multiple loops within the ladder to quantify ascent rate. As an aside, caution is recommended in installing PIT loops (especially using wood/metal antenna support frames in the path of fish); PIT installations cannot interfere with hydraulics or movement of fish.

Question 3: Fallback

a. Considering available research, does the panel believe fallback is an issue (i.e. through existing Thompson Falls spillways or hydro generators)?

With the available research, it is unknown whether fallback is an issue. It is unknown whether fallback occurs in large numbers and even that is not necessarily an indication of failed passage (perhaps fish were exploring and motivation to move upstream wasn’t significant). It is unknown whether the fish are injured when passing through the units. (Desktop methods can estimate blade strike potential, though an accurate assessment requires biological evaluations using balloon tags or similar methods.)

b. **If yes, what does the panel recommend as next steps to reduce the risk of fallback?**

The conventional approach is to ensure that velocities (within approximately 50 ft) are not in excess of swimming capabilities at the ladder exit. In other words, you want to ensure that fish exiting the ladder are not swept downstream (to the powerhouse). However, swimming speeds might need to be discounted (lowered) if fish are fatigued by moving through the ladder. Fatigue could be evaluated by (expert) inspection at the trap; more advanced methods are possible such as measuring stress hormones in fish. (This would need to be done on Rainbows or another non-listed surrogate).

Question 4: General Questions

a. **Does the panel recommend additional radio telemetry studies or other studies to gain further insight into delay (considering the risk to Bull Trout from additional handling and tagging)? If so, what is the panel recommendations regarding the use of surrogate species? If only Bull Trout should be tagged, what is an acceptable sample size to pursue?**

Yes, additional radio telemetry studies are needed, and surrogate species should be used to achieve a sample size that is adequate to help answer the questions (above and below), and through a range of flows, time of year and other co-variates. A minimum of 50 fish should be used, and potentially more if capture locations, species, fish lengths, time of year, etc. differ.

Telemetry on a small sample size of Bull Trout is not likely to be very informative. Combining CFD (i.e., hydraulics) with telemetry of other more plentiful salmonid species movement, may help identify hydraulic issues in the approach to the ladder. USGS Conte Lab can be consulted to help determine ideal sample sizes.

b. **What is the panel's recommendation on how to utilize other salmonid species behavior related to the ladder as a surrogate for the overall low numbers of Bull Trout available to be captured?**

As discussed above, using Rainbow Trout or Brown Trout as surrogates (modified by difference in body length) coupled with CFD may provide insight into limitations on Bull Trout movement. Given the Bull Trout's preference for moving at the margins, 2D or even 3D CFD will allow you to extrapolate Rainbow movement into the lower velocity margins to estimate Bull Trout movement.

Surrogates may also be used to understand the following:

- Route fish take to the fishway.
- Length of time it takes once fish enter the project area (far field) to when they find the fishway (quantifying delay).
- Areas where fish concentrate on upriver migrations.
- If fish can be, or if they are, attracted from left abutment to the fishway.

Radio telemetry combined with a CFD model is also recommended. A beneficial study could be developed that captures fish that have migrated to the fishway (right abutment), left abutment, and the old powerhouse; radio tags and transports them downstream of the project area, and tracks their movements upstream. A potential source of bias in this study would be pre-selection of fish that have already found the fishway and a confounding factor is the invasive and stressful handling and implanting of radio transmitters in the fish, which could potentially alter their natural movements. Uncertainty could be introduced from not knowing if fish were just naturally congregating in these spots before capture, or if they had migrated to these capture locations. Using Rainbow Trout that are at these locations during the spawning migration period, and even ones that are close to or ripe, could mitigate these effects.

In the past, Bull Trout have been used to understand fish movements around the dam, but the sample size was too small, and the reason for their upriver movements was not clear. Another approach would be to capture Brown, Westslope and Rainbow trout, upstream of the dam in the Clark Fork or Thompson River, implant them with radio transmitters and release them downstream of the project area and track their movements upstream (like above). By superimposing fish from one population (upstream) onto another (downstream population), fish should return to their capture population (upstream). In conjunction with this, it would be good to capture, implant and superimpose fish in unbounded sections of river as a control group to determine overall rates of return.

Question 5: To what extent is there interaction among or between question 1 through 4 topics above such that any follow up analysis (studies) or any implementation of corrective measures can or should be effectively coordinated for cost effective results?

Panel Recommendations

The Panel recommends adopting the 3-component efficiency framework (attraction, entry, internal) to describe ladder effectiveness using the proportion-time-effect metrics. Our review of the available information suggests that internal passage efficiency, while unknown, is often easier to resolve and dependent on sufficient numbers of fish entering the ladder. Since the fish counts are low (especially Bull Trout), we recommend focusing on quantifying attraction and entrance efficiency.

Therefore, we suggest NWE initiate two parallel studies to assist in the determination of the ladder's attraction and entrance efficiency:

- two-dimensional CFD study that incorporates measured or approximated bathymetry to resolve, at a minimum, a depth-averaged velocity field and water depths in the near field downstream of the dam/project.

- telemetry (radio-tag) study using sufficient sample sizes of surrogates to posit movement paths/rates and behavior in response to hydraulic conditions in the near field; the telemetry should be augmented by a literature review of the relative swimming capacities and behaviors of Rainbow, Westslope Cutthroat, Brown and Bull Trout.

As described above, the value of these studies will be optimized if they are linked. While the Panel has outlined the complementary nature of such studies, the exact objectives, methods and the integration of the findings will require careful consideration. Thus, we further recommend that the development of these study plans be done collaboratively with subject-matter experts from resource agencies, hydropower industry, federal labs, and/or universities.

We believe the approach described here will assist NWE and the TAC in determining, indeed quantifying, ladder effectiveness in a manner consistent with current scientific and regulatory standards.

The Panel appreciates this opportunity to contribute to NWE's efforts to promote the recovery of Bull Trout in the Clark Fork watershed. If you have any questions, please contact:

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References

Black Bear Hydro Partners, LLC. 2012. "Species Protection Plan", Supplemental Information Regarding Project Nos. 2710-057, 2712-074, 2534-092, 2600-080, and 2666-033 (Orono, Stillwater, Milford, West Enfield, and Medway Projects), pg 28.

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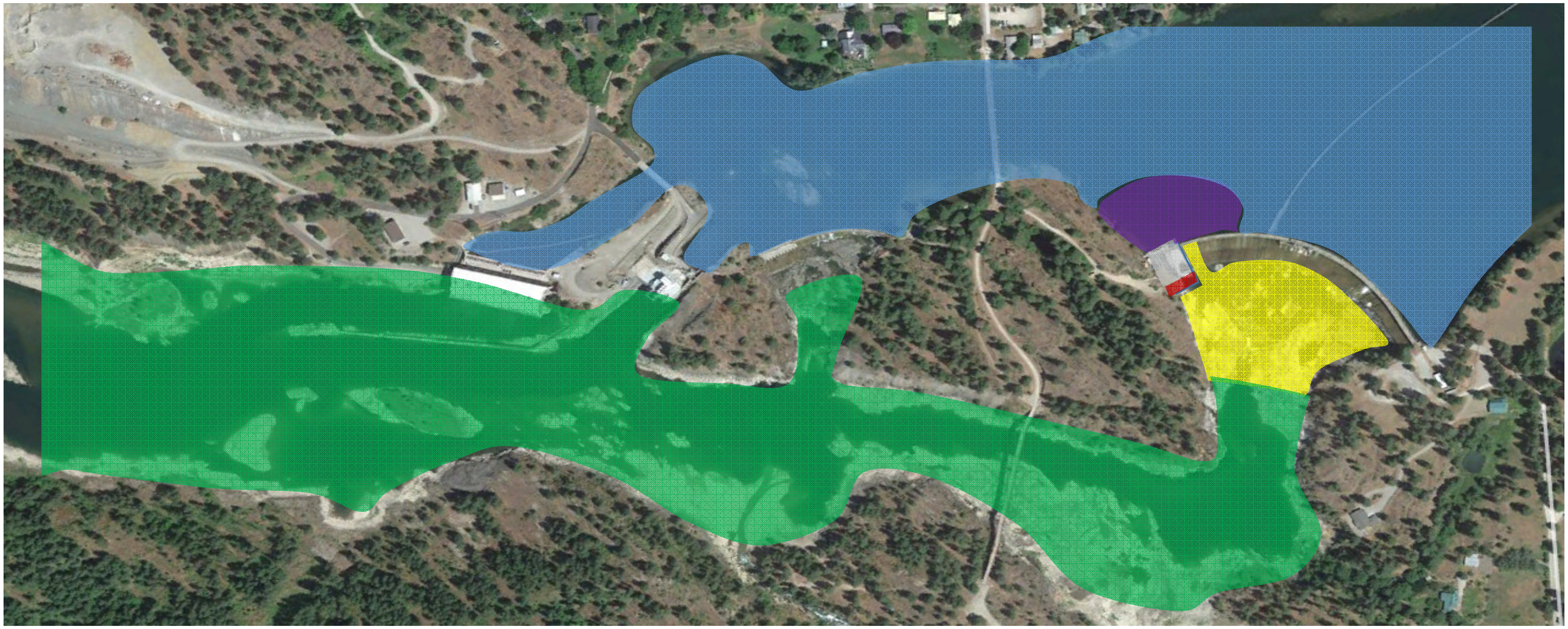
Towler, B. 2019. Email correspondence with R. Beaumaster, DFO. September 6, 2019.

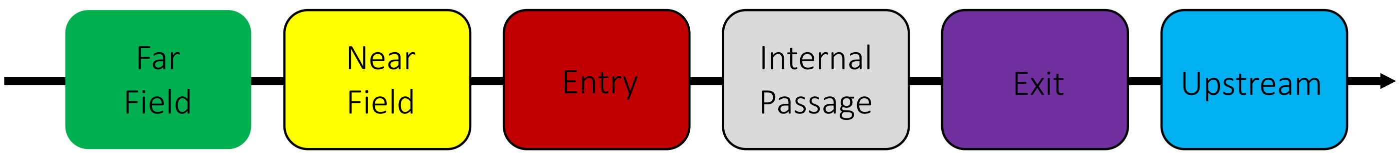
USFWS. 2016. United States Department of the Interior Modified Prescription for Fishways Pursuant to Section 18 of the Federal Power Act for the FERC Project #405 for the Conowingo Hydroelectric Project. U.S Fish and Wildlife Service, Northeast Region, Hadley, MA. June 8, 2016.

USFWS. 2016. Biological Opinion for Thompson Falls Hydroelectric Project Bull Trout Consultation. U.S Fish and Wildlife Service, Montana ES Field Office Helena, MT. October 29, 2008.

Attachment A- Zone of Passage



COMPONENTS OF THE THOMPSON FALLS FISHWAY ZONE OF PASSAGE (ZOP)



ZOP	Zone of passage, or path, that fish use to move through the influence of the project/dam
FAR FIELD	Downstream of fishway/dam where PH and spill serve as primary attraction to migrating fish
NEAR FIELD	In proximity to fishway where fishway attraction flow may lure fish to entrance
ENTRY	Immediately downstream of entrance channel/gate where fishway discharge dominates hydraulics/velocity field/fish behavior
INTERNAL PASSAGE	Hydraulics, structures and fish movement within the ladder (i.e., entrance channel, pools, trap, exit channel)
EXIT	Immediate upstream of the fishway exit gate/exit channel where inflow into fishway dominates hydraulics/velocity field/fish behavior
UPSTREAM	Beyond the influence of the fishway into the impoundment