

**Dominion Energy, Diadromous Fish Restoration and Technical Advisory Committee (DFRTAC)
American Eel Working Group
28 September 2020**

Conference Call Scheduled from 0900-1100

Final Meeting Minutes

Present (Conference Call Attendees):

Dominion Energy - Peter Sturke, Corey Chamberlain, Paul Vidonic, John Swenarton, Caleb Gaston
NMFS - Fritz Rohde, Twyla Cheatwood, Bjorn Lake, and Kevin Mack
USFWS - John Ellis and Doug Newcomb
NCWRC - Jeremy McCargo
NCDMF - Todd Mathes
VDWR - Dan Michaelson and Scott Smith
AKRF - Justin Krebs and Carlos Lozano
R2 - Gerald George
EPRI - Jon Black
Alumni - Bob Graham

Agenda

- Dominion Energy Update
 - Upstream Passage numbers at Roanoke Rapids and Gaston
 - Upstream Passage at Gaston
 - Facility construction update and estimated schedule
 - Effectiveness and Distribution studies
- NMFS Update on Upstream Eel Passage trends - Twyla Cheatwood and Kevin Mack
- USFWS Update on Eel Habitat in Roanoke Rapids Lake – Doug Newcomb
- Adult Eel Population and Movement Update – Justin Krebs (AKRF)
- Fish Friendly Turbine Replacement Analysis – Jon Black (EPRI), MaryLou Keefe and Gerald George (R2)

Dominion Energy Update

Pete started the meeting with an attendance check followed shortly by a review of the agenda. He asked the group about continuing the morning session to accommodate afternoon conflicts of some members. The group agreed to proceed and try to squeeze in as much in the morning session as possible. Pete oriented the group with Roanoke Rapids and Gaston dams and showed the group where the bypass, tailrace, and associated eel traps are located below Roanoke Rapids Power Station. Upstream passage at Roanoke Rapids thus far in 2020 has been very low but we have seen that in the past. As of last week, the Roanoke Rapids Eelways have caught 10,787 eels with 1 mortality (unknown cause). The numbers observed in the eelways at Roanoke Rapids this spring were very low but similar to the 2015 passage season. Just last week, the Rapids Eelways had a significant increase in numbers potentially indicating a productive fall passage season. Corey discussed that one change that Roanoke Rapids Power Station has been handling thus far in 2020 is that the skimmer gate on the south side of the bypass has been out of operation. The skimmer gate is the southernmost bypass spill and the South Eelway is attached to the training wall on the north side of the skimmer gate release. Corey described that the gate is not operational due to a failure in the mechanical components that have failed and been repaired a number of times. They are now going to be redesigned and remanufactured. This may take a

year before the gate is operational again. This may have had a slight impact on catches at the South Eelway, but RR Station operators have been opening gates on the southern side of the bypass to evenly distribute the flows to the North and South Bypass as described in the FERC license. Pete finished up Roanoke Rapids by noting that the eel contractors described the elvers caught at RR eelways last week as “larger” than the spring eels.

Pete then moved upstream to Gaston Dam and reoriented the group on the passage history and current status of the eel traps at Gaston. As of last week, the South Gaston eel trap has caught and released 2,284 eels after tagging with Coded Wire Tags (CWT) into Lake Gaston. The South Gaston eel trap has recaptured 2 eels in possession of CWT which have not been extracted yet to determine passage timing. Pete showed a figure of monthly distribution of eel catches at the South Gaston Trap which showed large catches in May and June of 2020 similar to historical trap results.

To update the group on the Gaston Upstream Eel Passage Facilities construction, Pete informed the group that the Generation Construction Project Manager has been taking the lead on permitting, procurement and construction activities for the facilities. The North and South Eel passage facilities at Gaston were permitted together and the US Army Corps of Engineer permit as well as the NC Department of Environmental Quality permits have been received by the project. The last hurdle for the project is the Stormwater Pollution Prevention Plan permit which has been received by North Carolina and is in process. This permit will allow the construction team to break ground. Regardless, the team is still targeting completion of the new North and upgraded South Eel passage facilities at Gaston Dam in 2020 however, the permitting delays experienced thus far in the process may push the completion into early 2021. Pete noted that Dominion will be informing FERC of this potential delay and asked for any questions about the timing. No questions were brought up and Pete noted that the team is very confident in being able to complete construction and commission the new eelways by the start of the 2021 passage season March 1st.

Pete finished up the Dominion update by showing some progress pictures of the new eel ramps that have been fabricated along with their substrate and collection tanks. He noted that FERC accepted the distribution and effectiveness study plans associated with the upstream Gaston passage efforts. The distribution studies are underway and he showed a slide with the stations and relayed that no eels were captured in September sampling in Lee Creek or in the Summit Creek area of Lake Gaston. They are scheduled to complete a fall sample in October/November of 2020. The effectiveness testing for the new eelways will start with commissioning of the new eel passage facilities, likely in March of 2021. Pete asked if there were any follow up questions before the next presentation but there were none.

NMFS Update on Upstream Eel Passage Trends

Twyla described the driver for this study was to perform a comparison of 5 year and 10 year passage trends and evaluate environmental cues for upstream movements of eels at 4 different eel passage facilities on the east coast (Roanoke Rapids, NC; Conowingo, MD; Holyoke, MA; and St. Lawrence, NY). The environmental cues that were paired with eel passage data were river discharge, water temperature, and lunar illumination. The numbers of eels trapped shows that southern projects are catching more eels than the northern projects however there is considerable variation in catches between years. The square root scale show the data more clearly for variation at other facilities. The results of the analysis between facilities showed that eel passage is variable from year to year and may vary based on latitude. Roanoke Rapids had the highest amount of passage for the 10 year analysis while eel passage at Conowingo over the last 5 years was the greatest. Ultimately, 10 year averages are preferred for management decisions as long term data sets capture more of the variability.

Kevin then described the second objective of the analysis which was to evaluate the environmental cues and timing of upstream movements at the 4 facilities taking into account the 3 variables of river discharge, water temperature, and lunar illumination. Kevin talked the group through the Generalized Estimating Equations (GEE) used which is a regression model that allows multiple continuous covariates utilizing a poisson distribution and a log link function. The eel counts and environmental time series data are often serially autocorrelated and highly variable so the data were integrated into 15 day periods centered on the New and Full moon. Each project was analyzed separately and used the same 5-year time series as used previously. There were 64 candidate models and each project had various model selection criteria that were supported as each project has unique traits. Targeting Roanoke Rapids the model used included discharge with a 2 day lag, temperature without a lag, and lunar illumination with two day lag (all positive correlations). Kevin then showed figures of eel passage for each project with the environmental variables overlaid and the results reinforced a few points from the first portion of the analysis: eel passage is highly variable from year to year and the degree of variation may differ by latitude. Kevin also noted that upstream movements are positively associated with discharge with the exception of Holyoke. Additionally, upstream movements had mixed associations with temperature and lunar illumination. These results indicate that eels are opportunistic rather than reliant on one variable as a migration trigger. Latitude likely plays a role in total passage number and passage timing.

Kevin and Twyla discussed on the next figure which was later deemed the “spaghetti graph” which showed annual trends of passage for all 4 of the projects for the past 5 years. One point that was elucidated is that passage operations at Roanoke Rapids are well timed to capture the whole passage season. Holyoke is probably most similar to Roanoke Rapids due to placement in the watershed. St Lawrence discharge and temperature are relatively consistent throughout the year and may be why there’s the typical bell curve distribution of eel catch rates. Kevin and Twyla described some data gaps and research needs going forward and that lunar illumination likely does not tell the whole story. There may be relationships with cloud cover, turbidity, or project specific operations which may combine to determine “available light” more than just lunar illumination. Corey asked the group about the potential for day length being a factor considering the latitudinal variation in these projects. Kevin agreed and thought that may be a valuable variable to include. Twyla added that eel movements are highly variable. All three variables are correlated at all of the projects alluding to eels being opportunistic for passage rather than influenced by one or two environmental variables.

The group discussed temperature of eel trap vs mainstem river, discharge from the eel traps vs mainstem river. Roanoke Rapids eel passage operations are very well timed to capture the whole passage season (March – November). The lower 5 year average for Roanoke Rapids compared to 10 years average is interesting. Conowingo had very high passage in the first 4 years of operations. All variables are important but a single “passage trigger” is unlikely to be alone in its impact¹. Kevin

¹ Comment added from Bob Graham on 10/25/2020 - It seems to me that several variables may set the stage for movements, but the, at times, coordinated movements of large numbers of eels within a short time frame do indicate that some sort of a “trigger” exists in some circumstances. What may muddy the analytical waters is separate “background” movements that occur at a low/moderate level over longer time periods, and “coordinated” movements that involve larger numbers of eels moving over a relatively short period. Different factors may drive the two. May also be a good time to point out there may be a behavioral component to the “coordinated” movements.

discussed the data from the Roanoke Rapids project were very helpful and that project specific analysis is definitely possible for Rapids bypass vs mainstem considering the data availability.

Carlos Lozano – 2015 and 2016 eel passage at Rapids had higher discharges in fall. What does the group think about the influence of ocean distribution of eels? Are the peaks “real” or are they “missed”? Early in the season the eels seem to find the north trap and the south trap more in the fall. Twyla indicated that year-round flows may affect distribution of eels and possibly timing and abundance of migration upstream.

Todd asked if these eels are elvers rather than “fresh recruits.” Bob answered and recalled that the Eastern Carolina University study showed variability for timing of arrival at Rapids is based on glass eel recruitment abundance at the entry of the Albemarle Sound at Oregon Inlet (Fritz/Bob?). Bob recalled that we’re mostly dealing with elvers at Roanoke Rapids based on Jesse Fischers work.

Pete asked Kevin and Twyla about the end goal of this study being a publication. Kevin indicated that they are working on a manuscript and would appreciate any reviews by the group once it reaches that stage. It seemed everyone was interested in reviewing and relayed their appreciation for the analysis and excitement to see this work.

Doug asked if they had considered looked at “loitering” habitat downstream of the projects being a potential variable that may influence timing of upstream migration. There may be potential for looking at habitat available for projects. Twyla and Kevin agreed and added that size class data would be incredibly relevant for this type of analysis if they are available.

Justin asked how the model fit and how was the GEE model able to determine the best fit in terms of R^2 values? Did one work better than others? Kevin answered that one model didn’t seem to fit all the projects however there was one model for each project that fit best. The GEE compared all 64 models to each other and the one that had the best “fit” was used considering the high variability with this type of modeling especially when it comes to the data and the eel passage itself.

USFWS Update on Eel Habitat in Roanoke Rapids Lake

Doug Newcomb started the discussion by describing the history of this analysis that has been in the works at Roanoke Rapids for some time. Bob helped describe the nature of the study in absence of Wilson and that the AEWG was originally interested in the habitat available as it related to a potential carrying capacity of Roanoke Rapids Lake for upstream eel passage efforts. Doug showed a number of figures for where the analysis started with the 2017 quad sheet for bathymetry. The horizontal accuracy was 40 feet and the vertical accuracy is about half (~20 feet). This is decent but the eel pots from the population study have certainly helped with the bathymetry. Doug took the eel pot depth and water level of the lake during the deployment to derive the bathymetry within RRL. Shoreline LIDAR gave us roughly 9cm vertical accuracy and 5 foot contours in the raster data. Combining that with the 500+ eel pots there are still some open areas. There are ways to derive bathymetry from satellite imagery using a cloud free image of the area of interest and a clear view of the bottom in the image. Essentially the GIS model can be calibrated based on the points from the eel pot data. Cloud free imagery was December 12, 2019. 0.5 to 1 meter accuracy in ocean areas based on the bathymetry data using Sentinel 2. January 2020 imagery (muddy water) hides the analysis however December 2019, with a clear scene and clear water helped show the bathymetry in better resolution. Results of first run: Lake depth with

smoothing showing more consistency for bathymetry of the lake. Need a clear image with a higher water level. Doug needs to run the analysis with all 3 options to find the best pot data.

Action Item: Pete – Determine the method for eel pot depth measurements via boat sonar/depth finder and the GPS readings are from a handheld Garmin GPS. **COMPLETE.** Pot depth measurements taken with boat mounted depth finder and GPS from Garmin 64st.

Bob recalled that we were originally interested in the carrying capacity for Roanoke Rapids Lake and wondered if it relied on habitat, especially Dissolved Oxygen, and if we would see any changes with catch rate at Gaston eel traps. Bob recalled that original interest was generated from lower Dissolved Oxygen associated with the hypolimnion which would limit the amount of available habitat. If able to apply vertical profile water quality data to the model, you could generate a carrying capacity based on available habitat. The group discussed the path forward on the analysis and how we could apply a density to the available habitat to establish a carrying capacity for Roanoke Rapids Lake. Doug said that he has some more fine tuning to do but will work towards that goal with the current data available. Pete and Corey said please let them know if more data are needed from Dominion.

Break

Pete restarted the meeting and introduced the downstream eel studies that are ongoing. He briefly discussed the history of implementing downstream passage for eels at Roanoke Rapids and then transitioned into the timeline looking forward. The Article 401 of the FERC license was revised and approved by FERC in January of 2019 including the decision for implementation of downstream passage is in 2023. After discussing the results of the Alden 2018 report Dominion and the AEWG decided in 2018 that we need to know more about the eels within Roanoke Rapids Lake and the current status of the project for eel passage. Pete discussed specifics included in that report and that Dominion is currently investigating two potential solutions for downstream passage of American Eels: Part I – Nightly Shutdown of Turbines by studying the eel population and their movements; Part II – Replacing existing turbine runners with a fish friendly alternative. Justin Krebs with AKRF will discuss the eel population study and provide an update on the telemetry and movement study. Afterwards, Jerry George with R2 and Jon Black with EPRI will discuss their study on market availability of Fish Friendly Turbines for application at Roanoke Rapids Power Station.

Adult Eel Population and Movement Update – Justin Krebs (AKRF)

Justin introduced the Adult Eel Population and Movement Study to the group and pointed out that this update serves to inform the group on actions since the Year-1 report that was filed with FERC at the end of June. The eel population survey now has one full year of monthly trap sampling that was conducted from October 2019 through September 2020. 9 eels were collected in the traps as of April 2020 and we had some big eel catches during the summer of 2020. In total, 98 eels have been collected during monthly trapping with one recapture of a previously PIT tagged eel in September. Justin then provided a brief update on the Acoustic telemetry tagging and tracking. The team deployed three acoustic receivers in July at the east end of Roanoke Rapids Lake just upstream of the Rapids Dam which brings the total receivers in the network to 14. 13 eels were tagged and released to Johnson Pond in October 2019. 27 more eels were tagged with acoustic tags and PIT tags during the August and September trapping events and were released to the locations of capture. 6 eels outmigrated during the winter migration season of 2019-2020 which leaves 34 tagged eels at large in the system currently.

Justin reviewed the sampling design of the eel population portion and informed the group that 622 eel traps have been deployed over the last 12 months. 98 eels have been collected and PIT tagged at a minimum. 19 other fish taxa have been collected in addition to turtles and crayfish. Eels were collected

most frequently and in highest abundance in the Lake Central Zone. Regarding habitat preference (stratum), eels were collected with similar frequency (5 or 6 out of 12 months) in each of the four strata but in highest abundance in the offshore strata. Monthly eel trap results show that we observed very low catch rates during last fall and winter and high catch rate in spring and summer (peak of 29 in July). Justin correlated the eel catches with the bottom water temperatures observed during the eel pot events and the result showed the catch rate slowed substantially when bottom temperatures were below 15°C. He said that we're expecting a similar drop off in 2020 and, as the ultimate goal of the study is to capture eels to create an updated population estimate for Roanoke Rapids Lake, Justin suggested to the group that we should pause eel trapping efforts after a zero collection and water temperatures are below 15°C. Todd said that he has reservations about missing data but understands the necessity of expending effort only when catch is likely. Pete clarified that the nature of the sampling is to catch eels for the population estimate and the team would only stop sampling after zero eels are collected in the monthly eel pot event AND temperatures are below 15°C. Eel pot sampling would resume in March just like the upstream eel passage operations as to capture the entire window of activity for eels. Jeremy (NCWRC), Fritz and Twyla (NMFS), and Dan and Scott (VDWR) are okay with pausing eel pot sampling after a zero collection and bottom water temperatures are below 15°C and resuming in March. Todd (NCDMF) relayed the same concurrence after the above discussion.

AEWG Decision: Adult Eel Population study to pause eel pot sampling events after zero eels are collected during a monthly event AND water temperatures are below 15°C.

Justin continued with results from the acoustic telemetry tagging and tracking study. He noted that the full complement of receivers is in place with 8 receivers in Johnson Pond (1), Deep Creek (2), Lake West (2), and Lake East (3). The range testing results from RRL East indicated about 400 meter detection range for each with some overlap with the V9 tags detection range. There is a high probability of detection considering the swimming speed of an adult eel combined with the overlapping detection range and triangular orientation of the RRL East receivers. Justin continued with a tagging update and informed the group that we started by tagging 13 eels in Johnson Pond during October of 2019. 27 more eels were tagged in August and September of 2020 and all were released to Roanoke Rapids Lake to the location of collection with the eel pots. Pete informed the group that Aqui-S 20E was used as the anesthetic for surgeries and it worked very well with a higher dose than used for the 2019 surgeries. Justin continued that 4 tags are set to expire in October of 2020, 7 tags will expire in Sept/Oct 2021, 3 will expire in April 2022, and 20 tags will expire in Feb/March 2023. Pete said that he and Todd have reached out to the NCDMF folks to see if any other detections have been recorded on downstream receivers. Justin said that 6 eels have outmigrated from the system which leaves 34 eels at large for the study going forward. Todd asked about the mortality and confidence in "outmigration" moniker for the 6 that Justin mentioned. The group discussed and the nature of the question was targeting the detections and likelihood of survival when the eels are passing the project. Corey and Pete mentioned that the outmigration window for 2019-2020 paired with a full station outage where no water was passing through the turbines so blade strike or turbine mortality probability was zero. Justin also mentioned that the telemetry data indicated that the eels were leaving in pairs or groups when detected downstream which seems to indicate migratory behavior. Todd asked about movements in the lake and Justin mentioned that the majority of the movements of eels were in December and January when leaving Roanoke Rapids Lake.

R2/EPRI – Fish Friendly Turbine Evaluation for Rapids

Jerry George presented on this project and started by discussing the primary stressor for eels being the potential for blade strike and grinding. Eels have a large body and large number of vertebrae which may

help reduce the shear stresses. There's a lack of evidence that silver eel experience barotrauma (Pflugraph et al 2019). Research in this area has shown some evidence of a Francis turbine being more effective than a Kaplan turbine for eels due to the leading edge being more blunt.

RRPS has one variable pitch blade vertical Kaplan (U1) and 3 fixed blade propeller turbines (U2 through U4). Turbine survival at Rapids has not been tested however estimates are showing 62-63% survival for 625-821mm TL European Eels. Total project survival for RRPS was estimated at 74% (Alden 2018).

Jerry focused the group on the goal of their study which was to answer the question: Is there a commercially available turbine compatible with RRPS that has demonstrated eel survival success? EPRI and R2 conducted a feasibility evaluation for Dominion in 2020 which included the feasibility of Turbine Replacement (compatible with physical characteristics, existing infrastructure, and generating capacity and efficiency). They also investigated fish (eel-specific) turbine performance criteria which included field studies of strike, injury, and mortality and laboratory studies, and included modeling approaches. Jerry informed the group that they conducted interviews with Turbine Designers and Eel Passage Specialists and developed a Reference Library and database of eel turbine passage studies. More specifically, R2 looked for a turbine that was compatible with the physical criteria of Roanoke Rapids including: Range of head, operating flow, powerhouse footprint, and minimum efficiency criteria. The initial screening produced more than 24 turbine types however head and flow eliminated most alternatives. Jerry showed an engineering figure with a narrow band where turbine designs would be applicable at Roanoke Rapids. He noted that most designs incorporating fish-friendly features are for low head facilities.

The feasibility analysis resulted in a few turbine designs that may work: 1) Vertical Kaplan (existing) with modifications, 2) Fixed-blade propeller (existing) with modifications; 3) Minimum Gap Runner (Ice Harbor Design); 4) Alden Fish-Friendly Turbine; 5) Stellba Fish-Friendly Turbine (later eliminated for lack of efficiency and generation).

Jerry transitioned to the biological evaluation of the previously mentioned turbines that would be feasible at Roanoke Rapids. The Minimum Gap Runner (MGR) developed by NWW, HDC, ERDC, NMFS, BPA and Voith Hydro. These have been installed at three facilities in the PNW focusing on juvenile salmon including adult steelhead. Early designs for MGR at Bonneville Dam had 17% increase in survival for Steelhead compared to unmodified Kaplan turbines. Testing is needed to anguilliform fish, especially at the lower rotational speed at RRPS (128.6 rpm existing considering the generators).

Jerry then discussed the Alden Fish Friendly Turbine and noted that extensive laboratory testing of a prototype turbine unit operating at low speed/head/flow conditions and survival rates of yellow-phase American Eels were 99.6% (mean length = 249mm) and 98.3% (mean length = 431mm). It was noted that this was not tested under high speed/head/flow conditions and no testing has been completed at full operational scale or field setting.

Lastly, Jerry discussed the possibility of replacing the current runners with an updated design or modernized version of the existing runner design. There have been many lessons learned from other hydroelectric projects that suggest significant improvements in eel survival may be obtained by using a newer Kaplan or propeller turbine designs optimized for fish passage. Rapids may improve eel survival by reducing the number of blades, reshaping blades, or decreasing the rotational speed. Bob asked if that's a retrofit or a total replacement? Jerry said it would be a like-for-like swap and would have less associated work needed when compared to the Alden or MGR.

Jerry summarized the presentation and identified that the MGR and Alden turbines have potential for Roanoke Rapids however both have uncertainties. He noted that eels do not conform well to traditional turbine injury and mortality modeling approaches. R2 further consulted turbine design experts to get their thoughts on design modification for large-bodied fishes and predictive tools to aid the design process to develop an eel-friendly turbine. Jerry mentioned the updated BioPA/BioDE model that has been produced by the Pacific Northwest National Laboratory. He also mentioned the Turbine Blade Strike Analysis (USFWS desktop model) in addition to the eel-specific blade strike, injury, and mortality models. Bjorn mentioned that the blade strike model is based on equations from the 90's and would require considerable modifications to the model to even come close to estimating survival for the eel because of the absence of field data. Jerry agreed and mentioned the Franke (sp?) equation in general shows eel mortality being extremely high. PNNL updated the BioPA model (July 2020) which includes an eel specific component. PNNL still working on how eel behavior may influence blade strike probabilities and survival estimates.

Corey wrapped up the turbine replacement discussion and noted to the group that the structural ability is present within the dam to change over the turbines to a new FFT design. It has to be economical for the company especially when it comes to an evaluation with the rate payers footing the bill. The turbines were last replaced in the mid-1980's and are approaching that same timeline now.

Pete wrapped up the meeting, reviewed the presentations briefly, talked about the decision with the eel pot sampling and thanked all the presenters for their work. He noted that the minutes will be distributed in the near future and that he is envious of Wilson's ability to simultaneously take detailed notes while staying engaged in the discussions and presentations. Pete ended the meeting and hoped that we could meet in person in 2021, perhaps outside to commission the new eelways at Gaston Dam.

Meeting adjourned.